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Imposing a *Saving Sentence* On a SPENDTHRIFT

By WALLACE AMES, *Financial Editor*

I

THE usual mess of monthly bills had arrived, checks were drawn and the accounts paid. In addition to the current household bills there were a number of extras representing Christmas presents, holiday expenses and one or two luxuries which Mr. and Mrs. Matthews had allowed themselves.

All in all, after the bills were met there was just enough left in the bank account to see the family through until next payday.

"Same old story," remarked Mrs. Matthews in a sort of half-resigned, half-discouraged tone. "Another month goes by without our adding anything to our savings. It was the same all through last year. First thing we know another new year will slip by and we won't be any better off than we are now. How far did we actually get, Ralph, on that program we started a year ago New Year's to lay by at least $75 each month?"

"Not very far," replied Ralph Matthews, himself none too well pleased with the way they were making out. "Of course we banked the Christmas check from the Company as a starter, just as we did this year. But every month during 1927 one thing or another took the money. Expenses, expenses, expenses, just like a pack of wolves, seem waiting to snap up each month's salary the minute it reached our hands.

"When we were figuring things out the end of last year I was sure we could save $75 a month, and I still know that we ought to have done so. It should be easy to save at least that much out of our income. But there was nobody *making* me save and every month—February, March, April and May—right through the year, we spent for one thing or another the money we ought to have put aside for the future. And it was the same the year before, and the one before that. Why is it that the habit of spending money is so much easier to form than the habit of saving it?"

II

Across the street lived a family whose circumstances were about the same as the Matthews'. But in their home, the same evening, quite a different scene was taking place than the one just depicted. Being the 10th of the month, John Maxwell and his wife were also settling their monthly accounts. As the first order of business, Maxwell drew a check to a building and loan association.

"Did you see this notice from the B. & L., Olive?" asked John. "It says that after the current payment our shares mature. We have been making these $75 monthly payments now for a little over 11 years. According to my account we have paid in a total of $10,200 . . . and now we are going to get back $15,000!"

"What a lot of money!" exclaimed Olive Maxwell. "What will we do with it? Of course, we have known it was coming some day, but now that the day has almost arrived, I am overwhelmed with the thought of having so much money."

"I have been wondering myself what to do with the money," replied John, "and I have an idea to suggest. We are getting along nicely now, and do not need to draw on the income from our $15,000 . . . in fact, I see no reason why we should not keep right on saving out of our monthly earnings. But the idea I have is this: If we invest our $15,000 at 6% it will pay $900 a year, or $75 a month. Why not use that to start a new series of B. & L. shares? When they mature we will get another $15,000, making $30,000 in all gained from the $10,200 we have now saved. That will put us on easy street."

"That's a peach of an idea," Olive Maxwell agreed.

* * *

Both Matthews and Maxwell earned about the same salary . . . both families maintained about the same scale of living. There was only one important difference in the two as far as progress in getting ahead was concerned: The Matthews tried to save *without a plan;* the Maxwells saved *with a plan.* The Matthews saved *what was left,* if anything, after satisfying all their spending desires; the Maxwells *saved first,* and kept their spending within what remained.

People who find it difficult to get ahead with regularity usually manage to pay their rent and household bills each month, but they do not put their savings and investments in the same class with monthly expenses . . . as a regular monthly charge against income. If a man earning $6,000 a year should suddenly lose his position and have to take another paying $5,000, his family would manage to get along on the smaller income. There is room in any income for regular saving, if it is planned for. The only way to get ahead is to make your savings just as rigid a charge against income as current expenses.

For those who experience difficulty in saving with regularity, the Building & Loan plan is an admirable one to adopt. It demands regularity. And it pays a handsome reward for regularity. It demands regularity not for just a year, but for a number of years, until the amount saved, and the income it produces amounts to a worthwhile sum.

The Building & Loan plan originated over a century ago, (*Continued on page 5*)

Imposing a Saving Sentence on a Spendthrift

(*Continued from page 4*)

primarily as a means of aiding people to own their homes. But, associations have also achieved immense popularity among people who want to save money. While building and loan associations vary in certain respects, the following points apply more or less to all of them.

A fundamental of all associations is their co-operative character. They operate on a very economical basis, have very little overhead, and all shareholders participate on the same basis, according to the number of their shares, in the profits derived from loaning money to property owners.

This co-operative feature enables shareholders to obtain an unusually high return on their money. The profit in matured B. & L. shares is equivalent to approximately 5% to 7% compound interest or 6% to 8% simple interest.

One may deposit as little as $5 a month or as large a sum as he is able. On regular shares it is necessary to deposit the same amount each month. Many associations impose small fines on delinquents but these fines are used to swell the profits of all shareholders. The aggregate monthly deposits of shareholders is kept invested in real estate mortgages. Interest is not credited to shareholders' accounts monthly, or quarterly, as in a bank, but is reinvested and thus compounded. All the profits are paid at one time, when the shares mature. Each share matures at $200, representing approximately $138 savings and $62 profit. (The exact figures vary, according to the profits the association gains from its investments.)

Many associations also sell "full paid" or "income" shares. These permit outright investment of such sums as $100, $200, etc., and pay a stated rate of interest—4½% to 6%, according to the association.

Building and Loan associations are subject to state banking regulations and enjoy an honorable safety record. The B. & L. plan is fundamentally sound and the protection to shareholders compares with other safe financial institutions.

* * *

The great popularity of Building and Loan is indicated by these figures: For the year ended December 31, 1927 there were 12,710 local building and loan associations belonging to the United States League of Building and Loan Associations; they had a total of 11,305,000 investors, whose savings and profits up to that date amounted to $7,062,525,000.

The rapid growth of these associations in the last five years is shown by comparing the above figures with those applying to December 31, 1923, at which time there were 10,744 associations with a total membership of 7,202,880, whose savings and profits up to that date amounted to $3,942,939,880.

The outstanding usefulness of a building and loan account is the fact that it makes saving compulsory; it forces the individual to save regularly and to keep it

(*Continued on page 6*)

A vacation that lasts the rest of your life

HOW would you like to quit work some day and start out on a vacation for the rest of your life?

How would you like to pack your trunk, cash a good-sized check at the bank, pick up a traveler's map and decide which part of the world you would like to visit *first*?

Or perhaps you would prefer to settle down in a cosy cottage in the mountains or by the sea—a comfortable place where you can spend the rest of your days just doing the things you've always wanted to do "when you had time."

Sounds attractive, doesn't it! No more work. No more worries. Nothing but good times ahead, and of course, with all expenses paid.

The money question

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And if you should become permanently disabled and unable to make further payments on your investment, there would be no need for worry. Your payments would be *made for you* out of a special fund laid aside for that purpose.

This Free Book explains it

A 24-page, illustrated booklet, called "How to Get the Things You Want," explains the plan in detail. It tells not only how you can retire with an income when you are 65, but how you can leave your home free of debt—how you can send your children to college—how you can create an estate—how you can make sure your income will go on even though you should become totally disabled—how you can leave an income for your family.

The financial plan outlined in this book is so clear and so simple that it can be understood at a glance. It is so sound, so sensible, so logical that the minute you read about it you will realize that it works. Send for your copy of the free book today. There is no obligation.

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Imposing a Saving Sentence on a Spendthrift

(Continued from page 5)

up for a number of years, until his accumulations really amount to something.

Another advantage is the fact that all profits are accumulated, re-invested and paid in a lump sum when the shares mature, instead of being paid in driblets. The most important result of this feature is the liberal profit ultimately paid to the investor.

The Financial Department of POPULAR SCIENCE MONTHLY likes the building and loan plan because it is a strong force in forming the regular saving habit, it pays the investor a liberal income and it is a convenient method for both well-to-do people and those in moderate circumstances to provide for their financial future.

Most every community has one or more building and loan associations, but those who do not live near one may invest by mail with any of the prominent associations in New York or elsewhere.

To Help You Get Ahead

THE Booklets listed below will help every family in laying out a financial plan. They will be sent on request.

"How to Build an Independent Income" is the title of a new booklet by the F. H. Smith Company which explains conclusively how people of moderate means may obtain financial prosperity. **"55 Years of Investment Service"** describes the history of progress of the F. H. Smith Company as well as making an attractive suggestion in first mortgage real estate bonds. May be obtained by addressing the home office of The F. H. Smith Company, Smith Building, Washington, D. C.

The House Behind the Bonds reminds the investor of the importance, not only of studying the investment, but of checking up the banker who offers it. Address: Fidelity Bond & Mortgage Co., 1188 New York Life Building, Chicago, Ill.

"The Investment Trust from the Investor's Viewpoint," presents an explanation of this form of investment in easily understood terms, illustrated with some interesting examples of how the general investment trust will help the man with $100 or more to get ahead. Published for free distribution by United States Fiscal Corporation, 50 Broadway, New York. Ask them for Booklet IT.

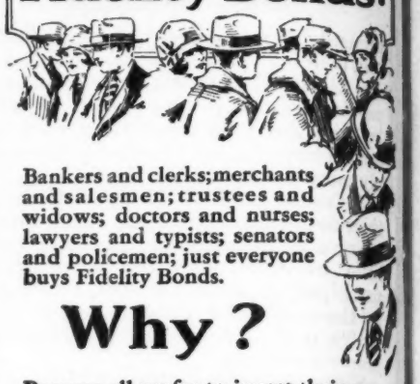
How to Retire in Fifteen Years is the story of a safe, sure and definite method of establishing an estate and building an independent income which will support you the rest of your life on the basis of your present living budget. Write for the booklet to Cochran & McCluer Company, 46 North Dearborn St., Chicago, Ill.

How to Get the Things You Want tells how you can *use* insurance as an active part of your program for getting ahead financially. Phoenix Mutual Life Insurance Company, 328 Elm Street, Hartford, Conn., will send you this booklet on request.

The Guaranteed Way to Financial Independence tells how a definite monthly savings plan will bring you financial independence. Write for this booklet to Investors Syndicate, 100 North Seventh Street, Minneapolis, Minn.

The Making of a Good Investment tells how 6½% can be made on investment in First Mortgage Bonds in units of $50, $100, $250, $500 and $1000; how the bonds are protected and how simple it is to purchase them. For a copy of this booklet address United States Mortgage Bond Company, Limited, Detroit, Michigan.

Who Buys Fidelity Bonds?



Bankers and clerks; merchants and salesmen; trustees and widows; doctors and nurses; lawyers and typists; senators and policemen; just everyone buys Fidelity Bonds.

Why?

Because all prefer to invest their surplus funds in a manner that brings them the largest returns with the greatest margin of safety.

Fidelity 6% First Mortgage Bonds offer both—a high rate of return and utmost safety for principal. Their payment, when due, is made doubly certain by our guarantee. Learn more about Fidelity Bonds. Send for the booklet, "Your Money—Its Safe Investment". A copy is awaiting your request. We send it gladly, without obligation.

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Write for booklet D-11 giving further facts, also ask for our financial statement showing resources of more than $22,000,000

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New products and new methods make building a thrilling project.

Help for You in Building

ARE you thinking about building a house or modernizing your present home? If you are, you are in for a thrilling time if you take advantage, as you should, of the advances that have been made in the science of building in the last few years. There are today many new products and new methods that you should know about before you build. Some will make for comfort, some for economy, and some for beauty.

How are you going to learn about these wonderful new things and decide which ones you should determine upon for your new house or your remodeled home? The answer is the new Building Service of the Popular Science Institute, which is now available to our readers.

The information that the Popular Science Institute has collected in your interest in connection with modern advances in home building has been obtained from every possible source where correct information could be secured. In many cases where there has been a difference of opinion in the value of a certain type of product, thousands of architects and building contractors all over the country have been consulted. Popular Science Institute has established in its building service a clearing house for facts and information such as exists nowhere else in the world and which will be of immense value to you or to every reader of this magazine who is planning to build or modernize a house.

The Institute Building Service is not intended to take the place of the architect, the building contractor, nor any other essential factor in the building of a good home; its aim is to guide the man who is building a house and supply him with the sort of information that will enable him to make intelligent decisions as to what he will have in his house. The Institute is committed to the use of better materials, better methods of construction, and modern equipment — even when a greater initial expense may be involved—providing it is convinced real satisfaction and economy will result, justifying their use.

You live now in a house that is heated in some way in winter (unless you live in the far South). Do you know how much of that heat is wasted; how much fuel you could save if the house were protected by one of the modern insulating materials? Do you know that immense improvements have been made in heating systems and the wonderful convenience and economy that these modern heating systems offer? Before you build you should decide what kind of furnace you need; what kind of fuel you want, and what kind of heating system it is you should have. There is much that you should know about outside materials; about roofing materials, in which immense progress has been made and in which lovely effects can be obtained inexpensively. You should know the way that walls can be put up very inexpensively now, if one wishes to do it, and you should know the latest improvements in flooring materials.

AND, too, there has been great progress in the matter of windows, in plumbing, and in refrigeration; and lighting is now a science that you should give thought to before your lighting system is installed. If you are living in an old-fashioned house, even though it may have been built many years ago at a time when everybody thinks of building as having been very substantial, you will probably find that cold air seeps in from a dozen points; through the floors, through the walls, through the attic, all of which makes it almost impossible to keep the house warm at any cost.

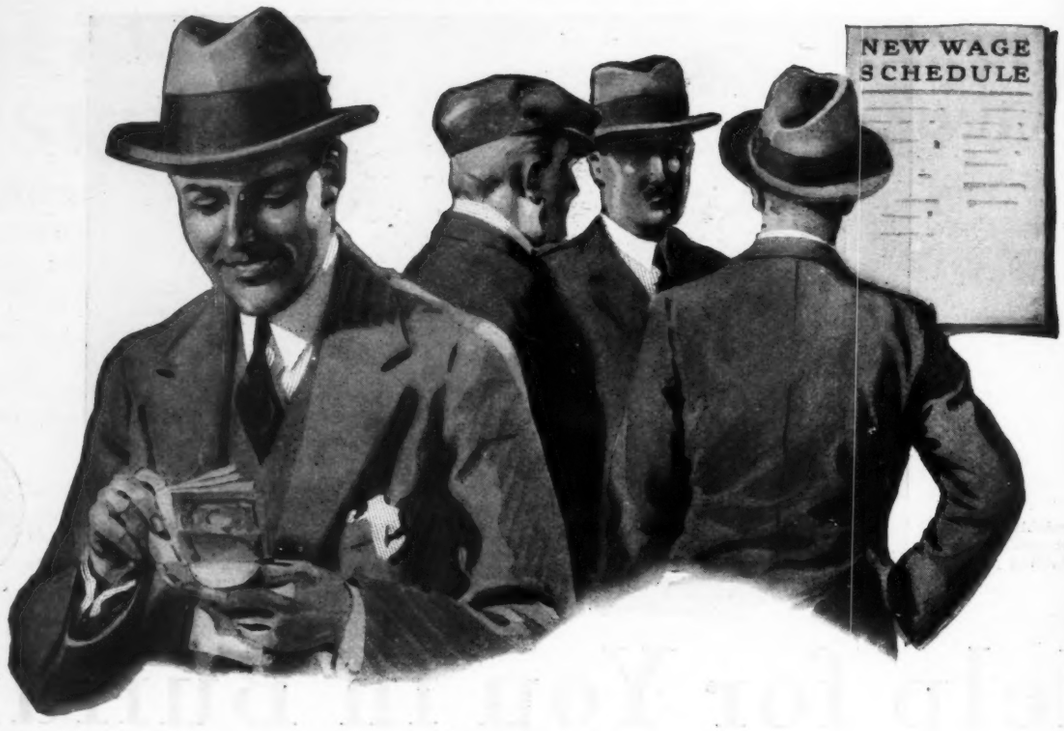
Whether you are planning to build in the near future or not, you will be immensely interested in the series of articles that will appear in the coming issues of POPULAR SCIENCE MONTHLY. These articles are the result of reports secured in connection with every line of building material, and check-ups made with thousands of leading builders and architects, together with information obtained from Government bureaus at Washington.

In questioning leading building contractors and architects regarding such modern features as insulation, scientific heating, new building products, etc., the Popular Science Institute has found that practically every one of these alert men was most anxious to know what the consensus of opinion of his colleagues was on the same subject. If the information gathered by the Building Service of the Popular Science Institute is of value to these authorities on building, it will be doubly valuable to the amateur builder.

TWO things that you naturally want your house to have are the greatest amount of comfort and the most economical operation possible. These things you can secure through the advice of the Building Service of the Popular Science Institute, based on careful, exhaustive research it has made on these subjects.

The Advisory Board of the Popular Science Institute Building Service is headed by Prof. Collins P. Bliss, Associate Dean of the College of Engineering, New York University. Working with him are William Dewey Foster, Practicing Architect in New York City and a recognized authority on the building of houses, together with George Allen Richardson, President of Geo. Allen Richardson, Inc., Engineers and Contractors, and also Construction Superintendent of the Eastern States Construction Co. The building articles to appear in POPULAR SCIENCE MONTHLY will be written by experts and the new service will be in their charge.

This Service is available to every reader of POPULAR SCIENCE MONTHLY, free of charge. Address questions relating to building materials and equipment to the Popular Science Institute Building Service, 250 Fourth Ave., New York.



His Salary Was Raised while others were reduced

"Up to the time I enrolled for a course with the International Correspondence Schools, I had only a grade-school education. Since enrolling, I have advanced to a much better position, where my salary is nearly four times as much as I was making previously. I would not be able to hold my present position had I not taken your course. Recently I received a nice increase in salary, while other men were being reduced."

READ that last sentence again—"Recently I received a nice increase in salary, while other men were being reduced."

There could be no better proof of the value of an I. C. S. course than that. It shows that the trained man is given preference over all others and paid more money, even in slack times, if his work deserves it. It shows that there are always bigger, better jobs open for men who have the foresight to prepare for them in spare time.

The home of the International Correspondence Schools—"The University of the Night"

Jesse G. Vincent was a toolmaker before he enrolled with the I. C. S. He is now Vice-president of the Packard Motor Car Co. Walter Chrysler, President of the Chrysler Corporation, is also a former I. C. S. student. So is "Eddie" Rickenbacker, the famous flying ace, who is now Vice-president of the Rickenbacker Motor Car Co.

An I. C. S. course enabled Fred W. Southworth to leave a poorly paying job he had held *for twenty years* and get a position as a salesman. In six months he increased his salary 300%.

George A. Grieble is another man who lifted himself out of the rut by spare-time study. He was a stone-cutter earning $15 a week when he enrolled with the I. C. S. He now has his own architectural and engineering business in Cleveland and his income is "between $10,000 and $15,000 a year."

If the I. C. S. can help these men to get out of the rut and make good, it can help you too. If it can raise the salaries of other men, it can raise yours! At least find out how.

The way is easy! Just mark the work you like best in the coupon below. Then mail it to Scranton today.

This doesn't obligate you in any way, but it brings you information that may start you on a successful career. This is your opportunity.

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If you reside in Canada, send this coupon to the International Correspondence Schools Canadian, Limited, Montreal

Manufacturers and inventors use this *grainless* wood to make good products better

The making of broad pieces, peculiar shapes and curved surfaces often makes it difficult to obtain low cost production. But Masonite Presdwood solves these trying problems. This grainless wood is readily cut, sawed, punched, or curved. It resists moisture and takes any finish. Write for a generous sample. Then try it for yourself.

FOR RAILROAD COACH CEILINGS

Reports of new uses for this grainless wood are coming in daily. A manufacturer solves a production problem, cuts costs or widens his market. A mechanic develops new ways of working and finishing it. An inventor finds it meets requirements better than any other material. And—three years after placing Masonite Presdwood on the market—we, who make and sell it, are still wondering just how far its range of usefulness will finally extend.

Builders of fast motor boats and outboard hydroplanes say that Presdwood gives their craft lightness, strength and speed. Contractors use it for concrete forms because the resulting smooth surfaces cut their labor costs to the bone. And from far and near come orders from makers of road signs who wish to take advantage of Presdwood because it is easily worked and quickly painted.

Presdwood IS wood

Presdwood is made of wood—exploded to separate the fibres—then formed, with heat and enormous pressures, into uniform boards, 1/8 inch thick, four feet wide and twelve feet long. The same wood binder (the lignins) that held the wood fibres together, again cements the fibres of Presdwood, but now there are no knots, no grain, and no cracking, checking or splitting to mar the beauty of the finished product, or worry the manufacturer.

FOR BEDROOM SCREENS

Where broad surfaces, beautifully finished, are essential—there you will find Presdwood. It is used in paneled walls of apartments and office buildings. It is used for broad side panels of motor truck bodies and the interiors of Pullman cars. And in the moving picture studios of Hollywood it is artistically employed to portray the ballrooms of the rich and the palaces of kings.

Does not warp—resists moisture

Because of its freedom from warping and buckling, and because of its resistance to moisture, we find Presdwood used for the tension boards of radio loud speakers, for bedroom screens, work bench tops, campers' tables, bread boxes, dairy product containers and starch trays for candy factories.

And when you try Presdwood for yourself, you will find that it will solve a manufacturing problem, reduce costs or make a good product even better. Write for a large free sample. It will be sent promptly on request.

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Mills: Laurel, Mississippi

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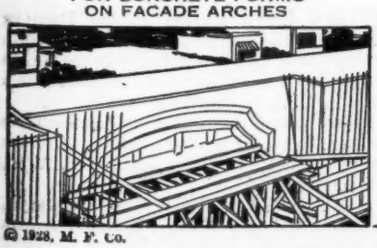
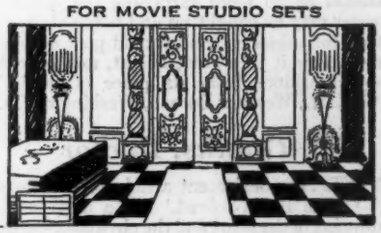


Masonite PRESDWOOD

Made by the makers of
MASONITE STRUCTURAL INSULATION

FOR MOVIE STUDIO SETS



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Our Readers Say—

Eyeglasses a Fad?

"I WAS amazed that either POPULAR SCIENCE MONTHLY or Dr. Free, whose articles I usually read with interest, should fall so hard for the propaganda of oculists and opticians as to publish that article, 'Must We All Wear Glasses?'

"What we need is not more glasses, but fewer glasses. Having eyes examined has become as much of a fad as removing tonsils and (a few years ago) cutting out appendixes. Indeed, I am convinced that the style of wearing specs, far from being a remedy, is one of the chief causes of America's failing eyesight.

"Take my own case. Three years ago my vision seemed perfect, I found no trouble reading anything and everything. But, being confined to close office work, my eyes would feel tired at the end of the day. A friend advised me to consult an eye specialist—and, of course, he prescribed glasses. The only difference I noticed was that the lenses slightly magnified. But, after wearing them a few weeks, I found I had become their slave. If I tried to read without them, a headache was sure to follow. The only result of glasses for me was weakened eyes, and the only profits went to 'specialists' who designed and made them."—A. R., Chicago, Ill.

It Rained Salt Water!

"WITH reference to a recent item on waterspouts in your magazine, I would like to add what seems to me to be an important correction to the statement that ocean waterspouts are not salty.

"Several cases are on record in our files of waterspouts that unquestionably carried sea water. Weather reports from seamen have told of salty spray being thrown on deck by passing spouts, and have mentioned the fall of salty rains from spout-bearing clouds.

"About two hours after the disappearance of the famous waterspout of August 19, 1896, off Marthas Vineyard, residents of the island were astonished by the singular fall of rain which they said was salt to the taste. The spout had an estimated altitude of 3,600 feet, and a quantity of sea water had been drawn to such a height and distributed about in the attendant cloud mass to such a degree as to affect the freshness of the rainfall.

"Now, while the greater portion of the ordinary funnel is undoubtedly composed of ordinary cloud matter—a condensation product—yet in local ocean whirls of great intensity it should be no more surprising that some sea water may be caught up and borne aloft, than that tornadoes on land should pick up wreckage, carry it to a great height, and bear it to some distance from its place of origin."—W. E. H., Weather Bureau, Washington, D. C.

Thanks, Doctor

"WITH your recent article, 'A Mystery of the Blood Solved,' was a diagrammatic drawing of the heart and the circulatory system. Out of thousands of drawings I have seen and studied, mostly in medical journals, and occasionally in lay journals, this drawing is by far the best. It is even instructive to me, who has dissected many hearts and examined thousands of patients for possible heart disease."—Dr. J. E. E., Grand Forks, N. D.

Airplanes and Death

"I READ with some amusement the sarcastic letter 'from a hero worshiper,' in which S. T. R., Jr., inferred that the Wright brothers, by inventing the airplane, foisted upon the world an evil machine of death. And it occurred to me that if the writer, instead of ranting about 'bloody Sundays in the air,' would take the trouble to learn the facts, his fears might be relieved.

"A recent official report of airplane accidents during the first six months of last year lists 390 mishaps, in which 153 persons were killed and 276 injured. At first glance this would seem a heavy toll, until we read further that in scheduled flying over established air routes, there were only six fatal accidents. The great proportion of fatalities occurred in 'miscellaneous flying,'—races and other contests, ocean flying, and experimental flying.

"And the airplane casualty list grows even less imposing when we turn to another report, recently issued by Louis I. Dublin, statistician of the Metropolitan Life Insurance Company. It shows that in the supposed security of American homes, 25,000 men, women, and children were killed by accidents during 1927! Of these 8,750 were killed by falls.

"I don't contend that the airplane is foolproof. But compared with the hazards that surround us every moment, airplanes offer little to fear."—H. N. P., Detroit, Mich.

Good Enough to Fly

"I WISH to compliment the artist who painted the picture for your December number on his ability to picture mechanical devices. The plane is one that any pilot would be glad of the opportunity to fly. It would be my suggestion, however, that before the pilot of this particular plane revs up his motor very fast, he have his mechanic change the propeller. It would be hard to say just what to expect if the present one were left on the motor. At least he couldn't expect to gather much headway."—L. B., Urbana, Ill.

Saved Their Money

"I READ with profit Alexander Senauke's article about the new radio gyps and their trick aerials. My receiving set is nearing completion, and I was about to send for a certain underground aerial. In this letter I hope to express my gratitude to your magazine for good advice. I believe I am one of thousands that profit by the 'Institute of Standards.'"—R. S., Hastings, Mich.

"Today I received a letter soliciting my order for an underground antenna. Thanks to your experiment, I can keep five dollars or thereabouts for something else. Much obliged."—O. E. W., Chicago, Ill.

More about Gliders

"I NOTICE in POPULAR SCIENCE MONTHLY that there is added interest in flying, stimulated by those 'jolly Germans' at Cape Cod; so I want to have my say.

"From a major in the U. S. Army Air Corps, who was sent to Germany to study gliders, I find that a good safe glider can be built for $50 to $75; that, for a little more, they can be made to carry a passenger. They can be launched by elastic devices, catapults, or down inclines; or by being pulled by a few bicycles, a motorcycle, or an auto. They will take off certainly at thirty miles an hour.

"A glider pilot is an airplane pilot, but an airplane pilot is not a glider pilot. From the Department of Commerce, I found that gliders must be licensed like planes, but the pilots need not be. To quote the man who told me this: 'There is only the law of self-preservation applying to pilots of unmotorized aircraft."—J. S. R., New York City.

What Do You Say?

"PLEASE tell me what, in your opinion, is the world's greatest invention. Is it the lever, which has made possible modern machinery? The bow and arrow, which freed man from the tyranny of wild beasts and gave him time to think? Or the printing press, which made education possible for everybody?"—D. B. L., St. Louis, Mo.

In the Model Ship Yards

"PERHAPS you may be interested in hearing of my toy motor boat, built from your blueprints numbers sixty-three and sixty-four. The International Rotary Club of Nashville holds a Boys' Hobby Fair annually. I entered my boat as an individual exhibit and received the Grand Award. I am interested in boat building of all kinds, and turn first to the pages in POPULAR SCIENCE MONTHLY that carry this kind of news."—R. C. K., Nashville, Tenn.

"I have built all of the ship models described by Capt. McCann except the one of the *Constitution*. In my opinion, the *Mayflower* is the most beautiful and satisfactory of them all. And I can imagine no more fascinating hobby for anyone. Your blueprints are superior to any I have ever found."—H. F. O., Massillon, O.

Kind Words from Friends

"WHEN I first started taking POPULAR SCIENCE I wondered why you didn't make a weekly out of it, but it didn't take me long to find I couldn't absorb all of it I wanted to in a month."—C. A. S., Springfield, Mo.

"I have missed the trolley car and been late to school, but I have never, since I first saw your magazine, missed an issue."—E. A. C., Burlingame, Calif.

"I am a home worker with shop in basement, and could not get along without POPULAR SCIENCE."—J. W., Laramie, Wyo.

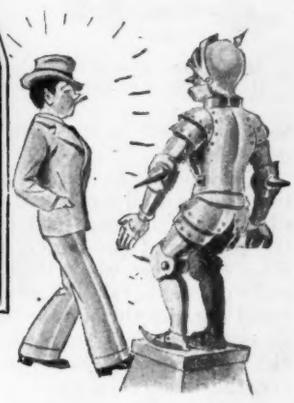
Popular Science MONTHLY

FEBRUARY, 1929 SUMNER BLOSSOM *Editor* VOL. 114, NO. 2

COAL *from* CABBAGES

By supplying fibers for our clothes, wood has "taken the candy" away from the cotton plant and silkworm.

A modern magician—Dr. Fritz Hofmann (left), chemist, explains how he makes synthetic rubber from coal.



With clothing of thin aluminum in place of wool or cotton, the well dressed man may rival armored knights of old.

And food from sawdust, lemonade from peanut shells, lumber from straw, cotton from banana stalks! More amazing than a fairy tale is this story of chemistry's latest magic. Here are adventure, wonder and romance right at your door

By GROVER C. MUELLER

ON THE speaker's platform in the auditorium of the Carnegie Institute of Technology at Pittsburgh some weeks ago, an unassuming man, hailing from romantic old Heidelberg, the famous university town in Germany, stood and announced in matter-of-fact tones that, after twenty-two years of experimentation, he had succeeded in making coal out of wood, cabbages, and cornstalks!

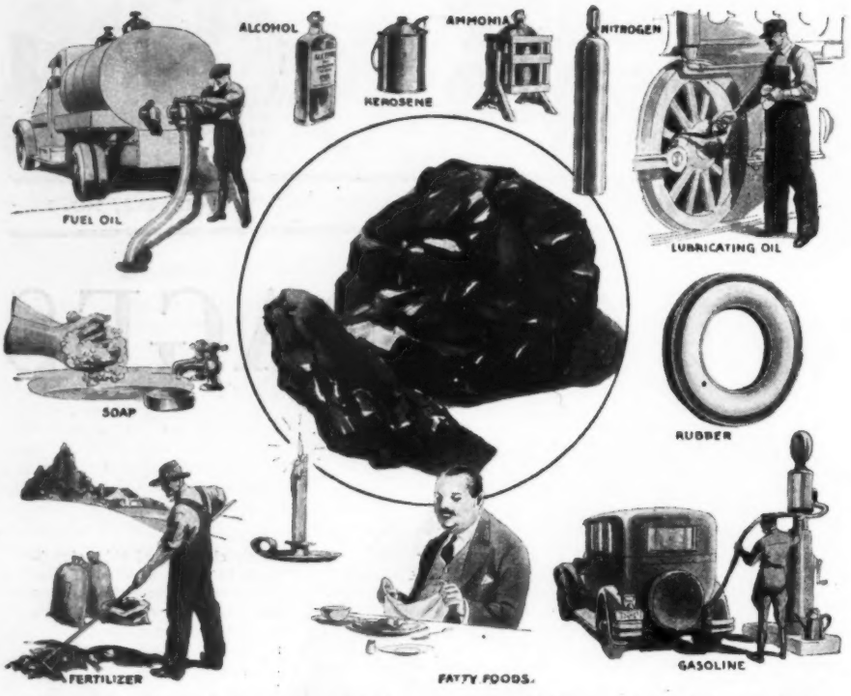
His low-voiced, undramatic reading of a highly technical paper was followed by an ovation from an otherwise austere and undemonstrative gathering of distinguished scientists from many lands, who were attending the second International Conference on Bituminous Coal.

Dr. Friedrich Bergius, the speaker, had taken eleven pounds of cellulose, a chemical derived from various plant and vegetable substances, mixed it thoroughly with water, and placed his solution in an air-tight vessel. Then he had heated it to 640 degrees F. and put the container in molten lead. After allowing this sealed cooking to continue for twenty-four hours, he had shut off the terrific heat, let the accumulated gas escape from the vessel, and waited for the liquid to condense. Result: eleven pounds of coal!

But in a broader sense, Dr. Bergius had done much more than that. He had leaped across the chasm of the ages and, in twenty-four hours, produced an indispensable substance which it takes nature twenty-four hundred centuries to create! Overnight, he had challenged her seemingly immutable laws with an invention which may avert fuel famine for untold future generations.

At the same conference, Dr. Carl Krauch, director of the German Dye Trust, fascinated the delegates with a description of the making and marketing of synthetic gasoline, obtained from soft coal. This year, a production of 70,000 tons was reached by the plant of the trust at Leuna; next year, an output of 250,000 tons may be attained.

FROM a business and scientific point of view, this is what happened: There was a shortage of oil in Germany; the price of the fuel had become exorbitant. Chemists of the nation set to work and turned coal into oil by various methods. In a way, it was a duplication of what Germany did during the World War; when, with nitrates cut off by a ring of warships, German chemists reached into the sky to take out of the atmosphere the artificial ammonia which had hitherto



Here are just a few of the important articles in common use which now can be made from coal and its by-products by the magic of chemistry. Dyes, perfumes, even wax, are among others on the list.

been imported, in the form of nitrates, from Chile.

But think of the deeper significance of this synthetic oil discovery! Consider its effects upon international relations and the peace and prosperity of mankind! What these chemists in their laboratories really did was to take the germs of another world war, put them in the test tube, and dissolve them out of existence! The conflict they averted was the giant struggle over the diminishing supply of the world's natural petroleum, which the great powers were supposed by some observers to be preparing. While demands for oil are growing by leaps and bounds, the available supply gives no promise of lasting longer than until the end of this century. And so, the pessimistic prophets of international rivalry predicted, there was no other way out for the nations but to engage in a death-grapple for the control of the precious liquid.

NO SOONER had Dr. Krauch finished his address, than F. X. Zur Nedden, secretary of the fuel committee of the national council of Berlin, told the assemblage of the vast economic advantages of the use of coal liquefied by a process of distillation! This method not only tends to diminish the importance of the earth's slowly vanishing coal supply, but it does away with the cumbersome weight and the ballast of ash and humidity inherent in the fuel's present form.

And another German scientist, Dr. Fritz Hofmann, revealed that he had produced rubber from coal in his laboratory. For the time being, he explained, the synthetic product is more expensive than natural rubber, but he is hopeful, through future experiments, of making artificial rubber on a large commercial scale.

Thus the conference presented an array of amazing discoveries showing that the dreams of the scientist are being turned into actualities that are bound to change the complexion of business and industry and make their benefits felt in the homes and daily lives of millions of men and women the world over.

Not only oil from coal and coal from oil, coal from cabbages and rubber from coal, but burnable gas from water, wood alcohol from coal, soap from coal, and even edible fats from coal—the day of synthetic bacon may soon be upon us!—were among the completed achievements or promising potentialities the scientists at the convention had added to the wonders of modern chemical industry. That industry now produces coke more useful than raw coal, dyes in colors more dazzling than the rainbow, perfumes more fragrant than flowers, and many other artificial articles that surpass Nature's own handiwork in providing humanity with comfort and pleasure.

SHORTLY before the conference in Pittsburgh convened, Dr. A. O. Jaeger, an American chemist, announced two new processes, involving the purification of anthracene, that will give the dye industry in this country an untold wealth of raw material now locked away in the black heart of coke and coal tar.

About the same time C. H. McDowell, president of the Armour Fertilizer Company, of Chicago, disclosed the invention of a method of extracting fertilizer from coal which will prove invaluable to our farmers in the raising of corn, winter wheat, and cotton. The plant food was discovered as a by-product when ammonia was eliminated from illuminating gas to obviate its unpleasant odor.

A few weeks previous, two German chemists triumphantly informed the world that, after years of fruitless attempts, they had succeeded in making food out of wood, or, to be specific, sugar out of sawdust! And on the heels of this announcement came the still more astonishing news from France that a scientist there had transformed coal into diamonds which, ere long, may grace the throats and hands of our American beauties!

This series of scientific events once more threw into bold relief the fact that the chemist has not only inherited the cloak and improved upon the arts of the alchemist of medieval times, but that he is the modern counterpart of the magician of the dark ages—the Merlin at the court of the Average Man, who is king in our day of democracy.

BUT unlike the practitioner of "black magic" centuries ago, the present wonder-worker does not aim to mystify and bewilder his fellow men. On the contrary, it is his purpose to clarify for them the blind and seemingly inscrutable forces that surround them on every hand in Nature, and to enslave these powers for their greater happiness and well-being.

The day is coming—has, in fact, arrived—when the chemist feeds us, clothes us, heats and lights our houses, and supplies essential fuel for the machines that transport us and make our daily necessaries.

Coincident with the news that scientists had managed to turn sawdust into food, came the report that a German chemical laboratory was beginning to turn out clothing made from aluminum in thin sheets to take the place of wool and cotton. And Dr. Warren E. Emley, of the United States Bureau

Chemists have found a way to turn waste sawdust into food for animals.

Artificial silk from peanut shells! Dr. S. J. Lynch, of the U. S. Waste Utilization Service, demonstrates here how it is done.

of Standards, told a meeting of members of the American Chemical Society recently that a lemonade made out of peanut shells and bran would soon be ready for commerce and consumption. One of the details that await further perfection is the name of the beverage, which at present, for lack of something shorter and prettier, is called "xylotrihydroxyglutaric acid"! But what's in a name?

HUNDREDS of other chemists throughout the world are engaged in transmuting waste into matter useful to mankind. They, too, are magicians of modern science. A young Philippine chemist by the name of Balingao not long ago invented a substitute for cotton fiber which he produced from hitherto worthless banana stalks! The process, resembling mercerization, consists of "cracking" off the cellulose binding of the fiber, which leaves it pure white and ready for weaving without having to be spun first.

Large quantities of straw in the cereal regions of our Middle West, where there are no forests, are being turned into material for insulating building boards. Its fibers are cemented together in long filaments.

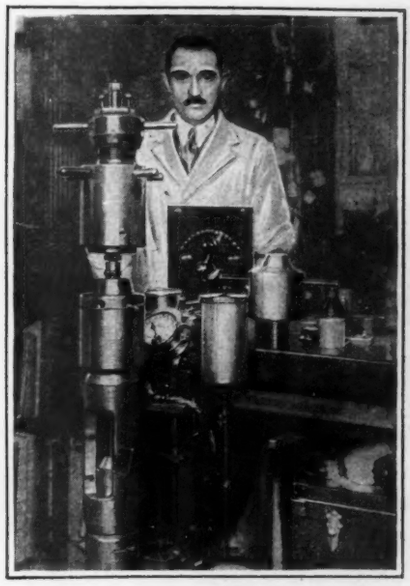
In the laboratory of the U. S. Bureau of Mines at Pittsburgh more than three gallons of wax recently were extracted from one ton of Utah coal! First, thirty-two gallons of tar were taken from the coal, and further experiments made the tar yield eleven percent of wax. The chemists who made the discovery declared that great quantities of wax, in no way inferior to the stuff now used in candles, may be produced from tar with little effort.

A little bird literally told English research workers in British Guiana how to obtain a substitute for cotton from a useless plant. This feathered fellow was seen building his nest with materials that looked like cotton, but which proved to be another plant stripped and treated by the bird.

The investigators brought the seed and roots to England. That was eight years ago. Now, between three and four million pounds of this artificial cotton is being grown on soil in Essex and Sussex counties that had been considered of no use for any sort of vegetation. And not only has the ground been put to good use, but the substitute cotton, which is said to be as good as the real article, is eight cents a pound cheaper.

THE transmutation of sawdust into food—one of the most striking examples of utilizing waste material—was accomplished by the simple process of adding one molecule of water to one molecule of cellulose, which with lignin is a principal constituent of wood. This chemical reaction had been known for more than a century, but until the two German scientists thought of it, the idea that, in this fashion, the enormous amount of waste wood contained in sawdust—about forty percent!—could be turned into food for animals and, eventually perhaps, for men, too, had never occurred to anyone.

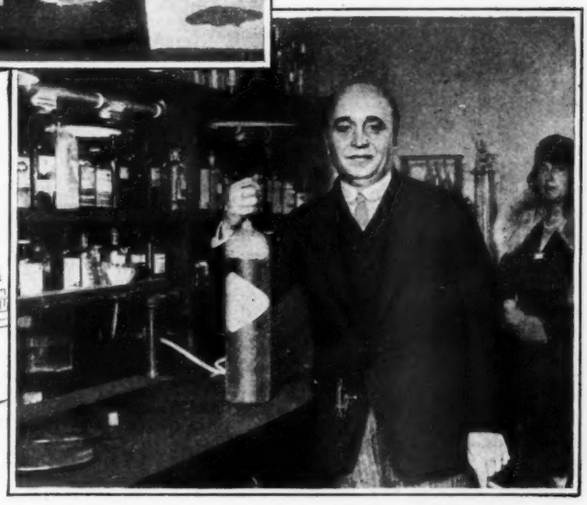
Only very recently, modern alchemists of chemistry discovered that seaweed could be turned into gold—but, of course, indirectly. On the Pacific Coast, a great seaweed industry has lately developed. It was discovered that this "worthless" plant contained properties similar to starch and gum arabic; in fact, it is superior to both, as it has fourteen times the stickiness of starch and thirty-seven times that of gum arabic. It "fills" cloth better than starch and leaves it thick and elastic instead of stiff. Chemists predict that it also will prove highly useful in dyeing and color-printing and that, before long, we may even eat it, mixed with certain other foods!



James Basset, French chemist, and apparatus with which he claims to make diamonds by subjecting coal to great pressure.

Lemonade made from peanut shells and bran soon may be a popular beverage. For this we have the word of Dr. Warren E. Emley, of the United States Bureau of Standards (shown at left).

Oil from coal and coal from oil—coal from cabbages and rubber from coal! New marvels spring from the chemists' magic crucibles.



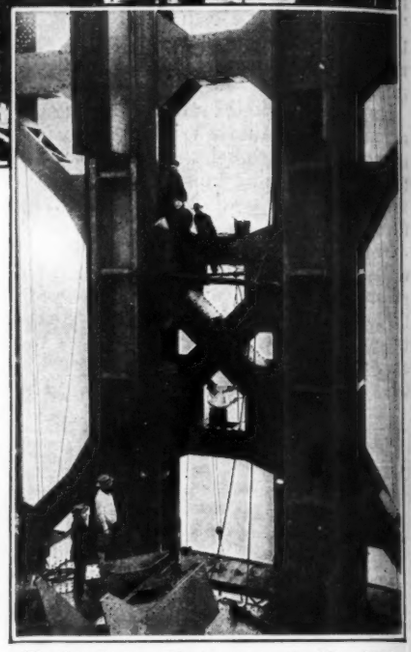
By brewing cellulose taken from wood, cabbages, and cornstalks, Dr. Friedrich Bergius, of Heidelberg, Germany, produces coal. This photo shows him in laboratory with jar of the synthetic fuel.

THUS, in a hundred experimental laboratories, chemists are finding ways of utilizing the things which we now throw away. And yet—curiously enough—the waste piles of the world continue to grow larger. Why? The answer is that there is more to the problem of utilizing waste than finding how to make it into some thing useful. There is the problem of transporting the waste to the factory, or the product to its ultimate market.

It is, of course, of not much use to spend time and money in reclaiming waste until there is a market for the reclaimed product which can be reached at a cost which will yield a profit. The new straw lumber developed in the Middle West, for example, is intended for use only in the treeless wheat country, where ordinary lumber has to be brought from a distance at great expense. But the product of the straw stacks cannot pay transportation charges to distant markets, even if it could compete with wood in markets where lumber is cheap.

Scientists, as a rule, are not business men and, fortunately for the sake of humanity, they persist in their investigations and laboratory experiments regardless of possible commercial obstacles. An ideal condition, of course, would be the utmost coöperation between chemistry and industry. And this is now coming to pass. Day by day, natural science and business are being linked more closely together. In this way, an invisible bridge is built that connects the wonderful dream-world of the laboratory with the living reality of your home and mine!

Building the Greatest Bridge



Rearing huge cable tower on the New York Shore. The towers rise 635 feet—eighty feet higher than the Washington Monument. Top: How the new Hudson span will appear when completed. Dark portions are already built.

The Story of One of the World's Most Thrilling Engineering Feats—Giant New Hudson Span Will Carry a City in a Day!

By EDWIN KETCHUM

IMAGINE all of the men, women, and children of Baltimore, Md., leaving their houses on a sultry August morning and piling into automobiles to rush away from the heat of the city.

Then picture this huge procession of automobiles,—about 200,000 cars in a line that would reach two thirds of the way from New York to Chicago!—passing in that one day across a suspension bridge of a single span 3,500 feet long, and you have gained an idea of the tremendous traffic to be borne on a summer Saturday by the greatest bridge in the world.

Realize, next, that all of these cars with their four fifths of a million passengers, besides hundreds of buses and electric trains, thousands of pedestrians, and the mammoth weight of the bridge itself, will be supported by four cables over a distance of fourteen city blocks, 200 feet above the water, and you have a conception of the boldness and magnitude of one of the most wonderful engineering feats ever attempted.

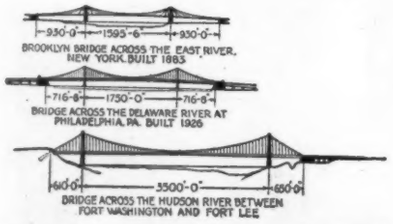
But such a giant bridge does not exist, you say. True! It will, however, be a monumental reality within a few years. In 1932, the new Hudson River bridge, dwarfing all other structures of its kind, will stretch across the Hudson from Fort Washington, in New York City, to Fort Lee, in New Jersey, giving New York a great new gateway to every part of the United States.

The main span of this titan among bridges will be twice as long as that of the 1,750-foot Philadelphia-Camden crossing which, since its opening in 1926, has held the record of being the world's longest suspension span. And the famous Brooklyn Bridge, with its 1,595 feet, will seem almost insignificant beside it.

Fourteen traffic lanes, including eight roadways, two sidewalks, and four electric railway tracks, will accommodate its unprecedented traffic. It is expected that 40,000,000 automobiles will eventually cross it in a year! Its total cost will reach $60,000,000.

The height of its finished cable towers —635 feet—will exceed that of the Washington Monument by eighty feet and that of the Singer Building, in New York, by twenty-three feet. They will hold a 90,000-ton fabric of steel and concrete in mid-air—twice the weight of the steamship *Leviathan*! The carrying cables will have a capacity of 350,000 tons, compared with 120,000 tons for the cables of the Delaware Bridge and 45,000 tons for those of the Brooklyn Bridge.

It is estimated that in the first year of operation 8,148,000 vehicles, containing some 19,000,000 passengers, will move across the new span, in addition to 1,500,000 pedestrians and nearly half a million buses!

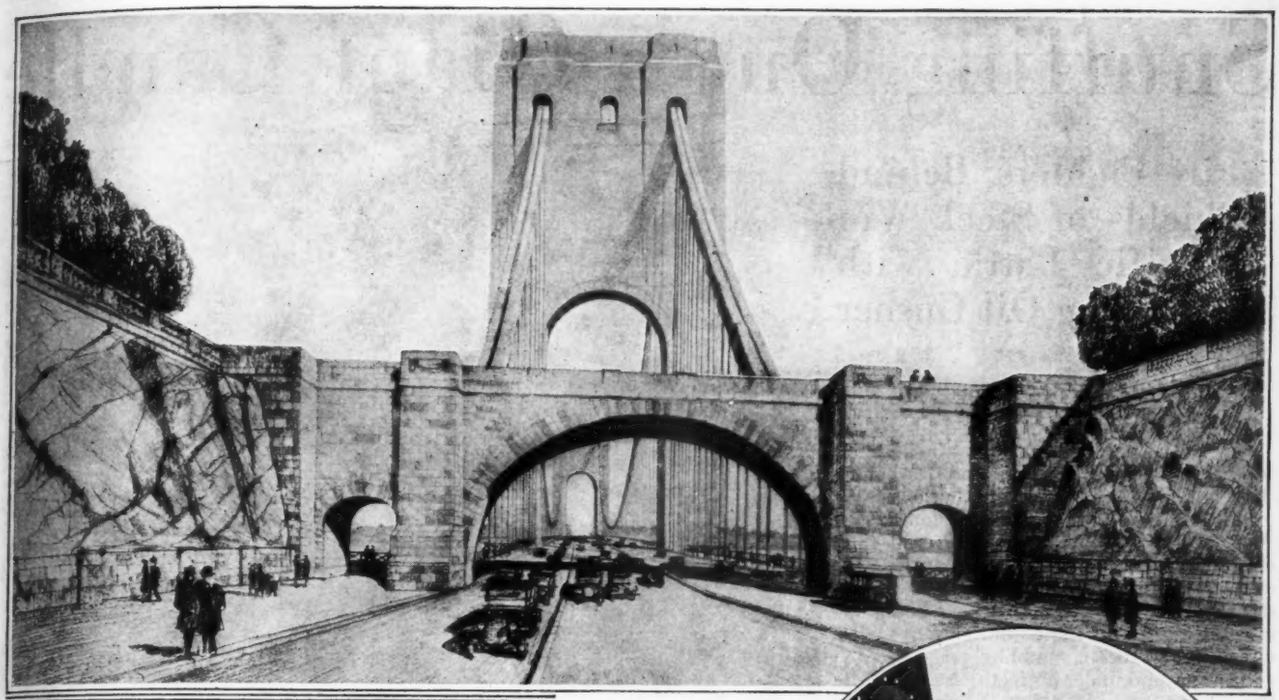


This comparison gives an idea of the gigantic proportions of the new Hudson suspension bridge. Its central span will be twice as long as that of the record-breaking Philadelphia-Camden bridge across the Delaware. And it will dwarf the once famous Brooklyn Bridge.

The magnificent structure, when completed in 1932, will have been made possible through the unique engineering undertaking of deep-rock mining operations on one shore, and erecting a man-made mountain range on the other. For the engineers were confronted with the problem of anchoring it in the solid rock of the Palisades that rise on the Jersey bank of the river, and of constructing a huge cliff on the New York side to match the natural stone opposite in everlasting power.

BEGUN in the summer of 1927, the work of construction is proceeding rapidly. Near the Palisades Amusement Park, on the Jersey shore, where young New Yorkers ride the scenic railways in search of artificial thrills, a mighty, stirring drama is staged daily with virtually no audience.

Building the huge cable towers that already have passed the 500-foot mark—which means (*Continued on page 144*)



The imposing approach to the Hudson bridge on the New Jersey shore, as it will look when finished. Here the huge suspension cables will be anchored in solid rock. Eight roadways will accommodate 200,000 cars in a single busy day!

Tower and approach on the New York side, as they will appear from the river. Tower contains 20,000 tons of steel.

Right: At dizzy heights above city roofs, the bridge workers balance on narrow steel beams.

No place for weaklings. Knitting together enormous steel girders 500 feet above the Hudson.

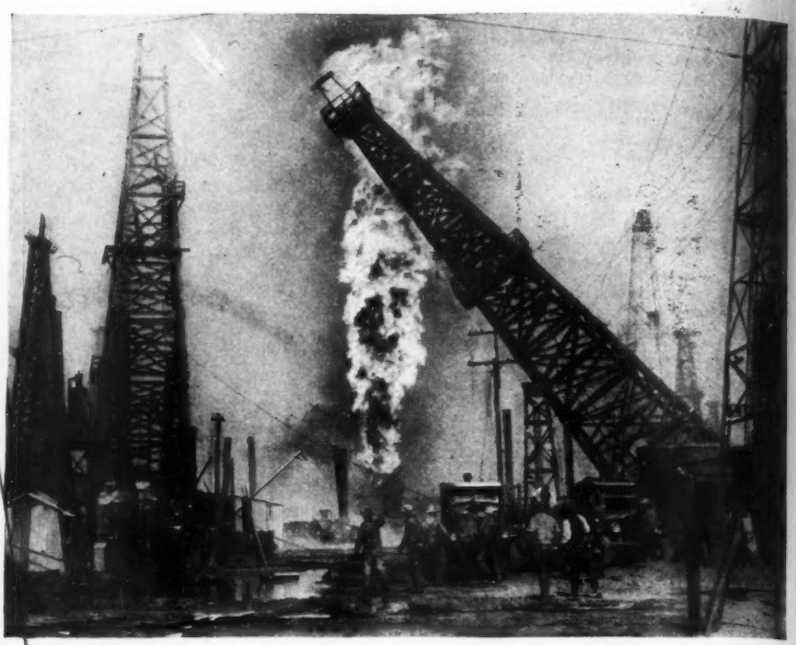
Below: Constructing concrete anchorage for the bridge cables on the New York side. This mountain of concrete covers almost a city block and is as high as fourteen-story building!

Giant fingers of steel begin to reach across the river. It's a thrilling job, and one of the mightiest engineering feats ever attempted. This photograph gives an idea of the tremendous size of the girders used in the construction of towers that will hold a ninety-thousand-ton fabric of steel and concrete in mid-air above the mighty Hudson River.

Snuffing Out a Giant Candle

Fire Fighters, Behind Shields of Steel, Win Terrific Battle with a Flaming Oil Gusher

By
JOHN E. LODGE



A breath-taking moment during the Bellevue No. 1 oil gusher fire. A huge derrick, weakened by terrific heat from the 200-foot pillar of flame, topples and crashes. Photo at left shows the five-ton steel cap which snuffed out a previous fire in the same field.

SOOT-SMEARED, an oil driller races across the sand. His face is distorted with fear, his undershirt scorched. Behind him, amid a cluster of twenty oil derricks like ant hills on a desert plain, a pillar of flame shoots skyward. One of the towers rises bodily into the air, and is hurled in a dozen directions. A deep, rumbling crash, and the ground under his feet quivers like jelly.

That was the scene when Bellevue No. 1, latest oil gusher in the rich Santa Fe Springs field near Los Angeles, Calif., "came in" the other day. When the drill point tapped an underground lake of oil, a column of the liquid spurted high in the air. Underground rocks came with it. A stone struck the casing. Sparks flew. In a second the gusher had become a 200-foot-high candle of flaming oil. Near-by derricks toppled, weakened by the frightful heat. Engineers advanced into the black smoke clouds, under protecting water streams from hoses, to raze more derricks and check the million-dollar fire's spread.

How can one of these spouting infernos of liquid fire be extinguished? This was not the first time an untamed oil geyser has menaced its drillers with fire. Lightning has made oil derricks its target and turned productive wells into death traps. Sometimes a harmless-looking grass fire touches off a well. Whatever its cause, a flaming pillar of oil, hot enough to melt a derrick's steel, is not a pretty thing to put out. Yet engineers have dared to attack these fires, with sensational success. One of their recent triumphs, oddly enough, has been just half a mile from the scene of the latest oil fire, where a novel system of putting out an oil blaze received a spectacular demonstration.

For eight weeks a freak fire raged about what had once been the derrick of Getty No. 13, in the same Santa Fe Springs field. Dense smoke billowed from the flood of seething, flaming oil, while above roared a smokeless jet of fiery gas. Advancing behind steel shields to screen them from the heat, fire fighters approached the terrific blaze. After a brief perspiring survey, they decided to try a desperate experiment—to snuff it out, like a giant candle.

First, a sapping project reminiscent of those of the World War was carried out. Under cover of the shields, tunnelers burrowed into the earth and dug an underground shaft two hundred feet long to pierce the main casing. Through it, sixty feet beneath the ground, quantities of gas and oil were diverted and the force of the burning jet diminished enough for the daring attempt.

TO SNUFF out the "candle," the men chose a five-ton cap of steel that looks like an inverted funnel. Its top is a stack with a huge valve, while at the wide-mouthed base is another pipe, with a valve, to lead off unburned oil.

Tractors and a daring crew popped this cap over the burning well. Instantly the funnel stack became a flame-spouting chimney. A turn of the valve wheel in the stack, and the flames went out—the pipe was plugged and the fire smothered. A hoarse command, and the valve on the lower pipe was opened in time to save the whole five-ton cap from being blown off by the accumulated pressure. Harmless oil poured out into a pit.

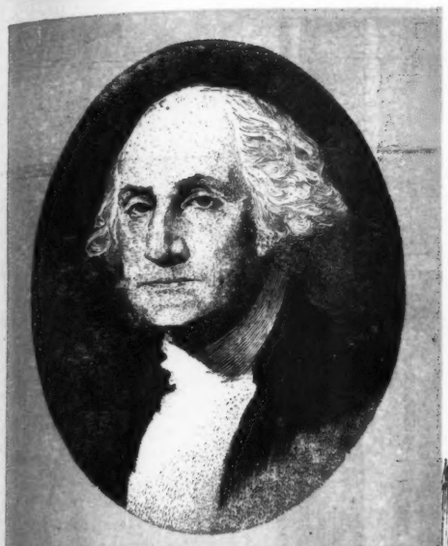
The fire was out!

Often nitroglycerin is used by the asbestos-clad men who extinguish oil well fires. Charges of explosives dropped into the blaze and exploded literally blow the fire out.

Clad in asbestos suits, like that shown at the right, fire-fighters attack the flaming well, advancing under the protection of steel shields that screen them from the intense heat.

Washington and Lincoln Both Were Inventors

New Light on the Great Presidents Whose Birthdays We Are Celebrating This Month



George Washington invented a plow to sow grain and cover it with earth at one time.

By

HOMER CROY

FEBRUARY brings to mind that two Presidents, both born in the same month, were, in their own right, inventors. They are George Washington and Abraham Lincoln.

And in their inventions they showed their different natures.

We'll take Washington first because he came first. Washington was the richest man in America; a country gentleman. He had an unswerving passion for practical things. Figures and exact quantities especially appealed to him. Once he set two workmen on his estate to counting how many seeds were in a bushel of clover. It took days, and when it was finished he carefully made a note of it.

Washington, on account of his social position, entertained a great deal. At his dinners he always served wines. One day as the bottles were going around he noticed that there was some confusion as to which bottle was which and what was what. His practical mind immediately fastened on it; here was something that needed remedying. He invented a device holding four bottles and which could be passed around so that all the bottles came to a guest at the same time. From these he could make his choice. In his own words Washington said of the contrivance:

"It will be more convenient for passing the bottles from one to another than handling each bottle separately, by which it often happens that one bottle moves, another stops, and all are in confusion."

The idea was similar to a caster, or a cruet for condiments for the table, except that it was more elaborate. It consisted of a little platform mounted on wheels so that the device with its freight of wines could be rolled along the great dining room tables used in those days. It was given the name of "coaster," as it could coast around the table.

The invention was pronounced a great success, and was taken up by the gentry of Virginia to such an extent that no formal dinner was considered correct unless it had a Washington wine coaster plying up and down the festal board to serve diners with the wine of their choice.

A wine serving device! Can you imagine Abraham Lincoln—that simple, homely son of the soil—inventing such a thing?

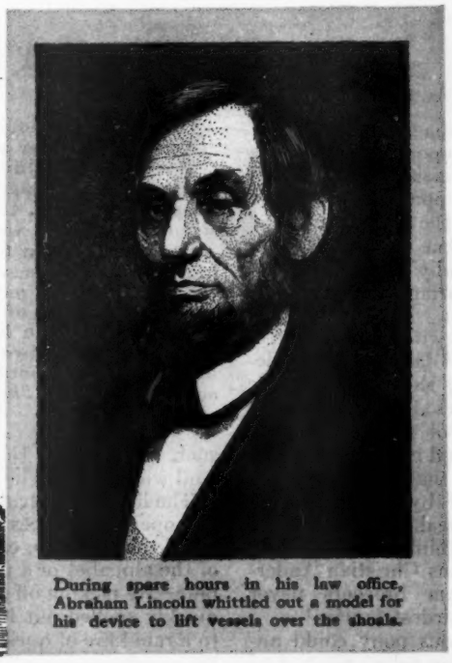
What next did the industrious, practical, Washington make? This time it had to do with his estate. It was a plow. He had seen a plow which had been brought over from England, and immediately his practical mind worked out an improvement. Then he called Peter, his smith, and set to work constructing it.

The plow, when finished, developed the curious eccentricity of not wanting to stay in the ground. Washington designed it all over again. At last the idea was whipped into shape, and then Washington proudly brought out two of his handsomest carriage horses and attached them to the plow. It nearly ruined the horses, for the ground was rocky and the plow began to jump, and the horses started to run away. Later, work horses were substituted and the plow was a success.

Twenty-eight years later Washington, returning to the idea, designed a plow which would do two things at the same time—sow the grain and plant it. It was a brand-new idea in agricultural machinery. Part of the device was in the shape of a barrel which discharged the grain, while behind was a roller which broke up the clods and kicked earth over the seed.

WASHINGTON never tried to make money from his inventions and they were never put on the market. But as President he encouraged inventions; he signed the first patent law passed by Congress and attached his name to the first letters patent issued by the United States.

Lincoln had no interest in stately dinners where a wine coaster would be a useful and pleasing device, or in farming. He was born on a farm and got off it just as quickly as he could.



During spare hours in his law office, Abraham Lincoln whittled out a model for his device to lift vessels over the shoals.

Lincoln turned to something he knew about. River boating. When Lincoln was twenty-one years old he went on a trip down the Mississippi River to New Orleans on a flatboat and for the work he did he received the salary of twelve dollars a month.

He got as far as New Salem, Illinois, the bottom of the boat grated on a milldam, and stuck. Nothing under high heaven could budge it. The front part

(Continued on page 137)

Mr. and Mrs. Tiger remembered! When their keeper advanced, holding a painting of an African big game hunter, the beasts screamed and fled.

New Proofs That Animals Really Can Think

Amazing Stories of Tigers that Reason, a Horse that Solves Deep Problems, and an Ape that Invents

By ROBERT E. MARTIN

HIS four shaggy feet firmly planted upon an exquisite $10,000 Persian prayer rug, a Shetland pony stood in the middle of the drawing room at the New York home of Sir Joseph Duveen, internationally known art connoisseur and antiquarian, one evening a few weeks ago.

All but speechless with amazement, a brilliant gathering of ladies and gentlemen in evening dress sat in a semicircle around the little horse. Theirs was the thrilling experience of seeing the fairy tales of their childhood come true.

For here, so close that you could feed him lumps of sugar by stretching out your hand, was a real, flesh-and-blood animal that could "think and talk" in a manner of which Hans Christian Andersen and the Grimm brothers never dreamed in their weirdest fancies!

Why, this marvelous pony could answer any question you asked him! And such questions as they did put to him! And what answers he gave!

ALMOST everyone has wondered at times whether animals really can reason and think. At the recent International Congress for Psychical Research in Paris, the subject, of long scientific conflict, was widely debated.

Here Mr. Martin tells of some amazing examples of seemingly human intelligence on the part of animals. No person, possessed of the slightest curiosity—whether he believes that these resulted from reason or from instinct and training—should miss this absorbing article.—*The Editor.*

The little horse had been placed before two openwork fences on which were hung small tin triangles, each bearing a letter of the alphabet or a numeral from one to nine. By picking off these tabs, the pony quickly spelled out his startling answers to a rapid fire of questions "shot" at him by members of his "audience."

The animal's replies gave evidence of an almost fantastically human intelligence. He could distinguish between men and women. He told the time. He gave the dates of historical events. He added and subtracted and—solved square-root and cube-root problems!

But judge for yourself whether this pony thinks like a man or not. The "conversation" ran as follows:

"What city is this?"

"New York."

"Do you like to come to town?"

A vigorous affirmative nod of the head was the answer.

"What do you do in the city?"

"Visit."

"Whom do you visit?"

"Nice people."

When the general laughter subsided, the animal was given sums to do. He added and subtracted rows of five figures unhesitatingly and without a mistake!

The clever pony was Black Bear, a

Shetland, whose feats have aroused widespread scientific interest. He was "discovered" by W. W. Fuller, a tobacco magnate, some months ago. At that time the pony, in charge of his owner, a Mr. Barrett, a venerable wanderer who might be called the American counterpart of Trader Horn, came to Mr. Fuller's estate near Briarcliff, N. Y. Both Black Bear and his quaint old master have been guests there ever since.

BUT to return to the demonstration at Sir Joseph's. After Black Bear had shown that he was no mean mathematician, the "interview" was resumed, thus:

"Black Bear, were you ever in another body?"

Again the affirmative nod.

"Whose body?"

You could hear a pin drop in the room as the pony reached for the tabs. His reply was:

"King Solomon."

A gasp of astonishment from the guests.

"When did King Solomon live?"

"B.C. Long time ago."

"When were you born?"

"February 25, 1917."

The conversation was interrupted once more, this time by Mr. Barrett, who showed the pony a small clock and asked him to tell the gathering what time it was.

Deliberately, Black Bear picked out the figures, "Nine twenty-eight."

"How many minutes to ten?"

"Thirty-two."

"When did Columbus discover America?"

"1492."

At this point, the pony made the only mistake of the evening. Asked to give the date of the Declaration of Independence, his answer was, "July 4, 1775."

"Bless his heart," said one of the women. "Perhaps he's tired."

"Not at all," explained Mr. Barrett; "that was just a slip of the tongue!"

NEXT, Black Bear was told to "go kiss the lady in the pink gown." There were five women in the room. Without a moment's hesitation, the pony walked to the wearer of the dress of the color indicated and "kissed" her.

Now came the final question.

"Black Bear, tell us where you get all your knowledge?"

And the pony spelled out: "G-o-d"!

Sir Joseph's friends looked at each other in mute amazement. Then Mr. Barrett casually remarked that the pony could solve square-root and cube-root problems! And so, for another half hour, the marvelous animal found a number of solutions quickly and correctly enough to make many a college student jealous.

Black Bear's astonishing performance came as the climax to a series of demonstrations of animal intelligence that have engaged the attention of scientists of late. Fellow, a remarkably bright six-year-old German shepherd dog, recently underwent a second psychological test at Columbia University, New York.

Fellow has a "vocabulary" of about 400 words; that is, he thoroughly understands that number of terms. And he proves his ability by responding to commands, or rather requests, in which that many different words are used. The average person, psychologists say, doesn't use more than about 350 words in his conversation!

SO FINE are Fellow's powers of perception that he can distinguish between the letters of the alphabet, and so knows the difference in meaning between words of closely similar sound. The Columbia psychologists placed a silver dollar and a linen collar beside each other on the floor.

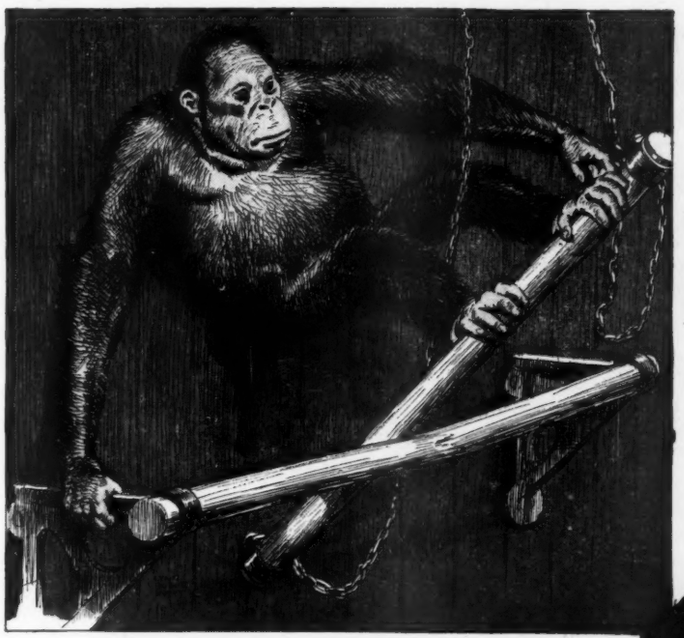
"Fellow," asked Jacob Herbert, of Detroit, his owner, "will you bring us the collar?"

The dog leaped forward and retrieved the desired object.

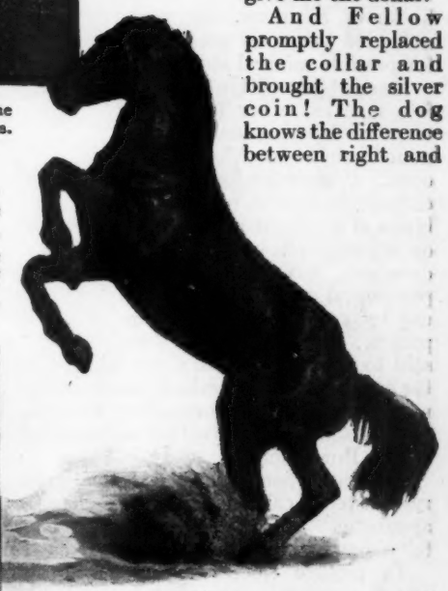
"Fine," said Herbert. "Now put back the collar and give me the dollar."

And Fellow promptly replaced the collar and brought the silver coin! The dog knows the difference between right and left better than some Army rookies, and distinguishes between men and women, adults and children.

One of Fellow's accomplishments particularly impressed the New York psychologists. Herbert asked one of the men to take the dog firmly by the collar. "Now, Fellow," he said, pointing to the secretary of one of the professors, "I want you to protect that young lady; don't let *anybody* touch her." The slightest move in her direction brought angry growls. Then, as Herbert himself walked over to the girl and started to touch her, even he was treated to bared fangs and threat- (*Continued on page 146*)



An inventor among the apes. With his trapeze bar, Dohong, the orang-utan, devised a lever with which he broke horizontal bars.



Rex, the wonder horse of the movies, is one of the most temperamental stars of Hollywood. He actually selects his own casts for his pictures. At the left is Fellow, the remarkable German shepherd dog, passing intelligence tests. He knows 400 words. In circle, Rin-Tin-Tin, the famous shepherd dog star of the movies.

Prospecting for Gold With Electricity

Amazing Instruments Find Hidden Ores and Bring New Romances to the West

By GEORGE LEE DOWD, JR.

Two types of direction-finding coils for locating ore deposits. At lower left is an amplifier to increase strength of the signals sent through ground and heard in headphones.

PROSPECTING by electricity is here.

The new method, which the U. S. Bureau of Mines' experts have just tried out in Colorado, discovers underground veins of metal without digging an ounce of earth. There is no need to drill costly "test shafts" where someone thinks there is metal. A few electric connections, and valuable deposits of iron and copper ore, the experimenters found, write their location on prospectors' maps. So portable is the apparatus used that it may be carried on the backs of a prospecting party and used to survey great areas for possible mineral stores.

Meanwhile, within the last few months, other fascinating ways of locating underground mineral riches have been developed. Prospecting for oil with earthquake shocks, produced by blasts of dynamite and recorded on seismographs or earthquake-detectors, has passed its experimental stage and is now in use by several great oil companies. Radio instruments are said to detect gold and silver hidden in the earth. Another method, which makes metal ores reveal themselves through magnetism, has been tried out successfully by the Bureau of Mines.

Will participants in the next great gold rush be technical men armed with electric apparatus—figures that look more like telephone linesmen than prospectors?

To picture electrical prospecting in action, imagine the strange scene at Caribou Mountain, near Nederland, Colo., where the Bureau of Mines experimenters tried out their apparatus. On a grassy knoll a signaler sits at the key of an Army field telegraph outfit. Two bare copper wires, connected to it, have been laid in parallel lines 500 feet apart along the stubble and rocks of the mountain—and pegged to the earth, every hundred feet, with metal stakes for electric contacts. As the telegrapher presses a key, a prearranged signal—three dots and a dash—flashes along the wires and into the earth.

TELEGRAPHER SENDS DOT-AND-DASH SIGNALS
UNDERGROUND CURRENTS SWERVE TO FOLLOW ORE DEPOSIT
ELECTRIC CURRENTS ENTER EARTH AT METAL STAKES AND CROSS TO OPPOSITE WIRE
ELECTRIC CURRENTS LEAVE EARTH THROUGH STAKES
WIRE WOUND AROUND RUBBER BOOT MAKES CONTACT WITH EARTH
DOTTED LINE SHOWS ACTUAL BOUNDARIES OF IRON ORE DEPOSIT
MAN WITH HEADPHONES WALKS OVER GROUND TO DETECT DIRECTION OF UNDERGROUND CURRENTS

How hidden veins of ore are mapped by telegraph dot-and-dash signals sent through the ground. The electric current carrying the signals follows the winding course of the underground ore deposits.

With headphones on his ears and a rubber boot on one leg, a man is seen strolling about, seemingly aimlessly, a few hundred feet away. He carries a trailing wire tethered at one end with a ground stake. Wound about the rubber boot is a bare wire of copper that he grinds into the earth at each step.

Actually he is listening intently to a three-dot-and-dash signal he is receiving in the headphones from the earth. Sometimes it grows louder as he walks; now, fainter. It has stopped altogether. He halts, and marks the spot upon the ground. That is a "silence point" that will be used to map the precious ore.

By these "silence spots" he can tell exactly what path electric currents take as they course through the earth from one of the parallel, pegged-down wires to the other. And the electric currents follow the ore!

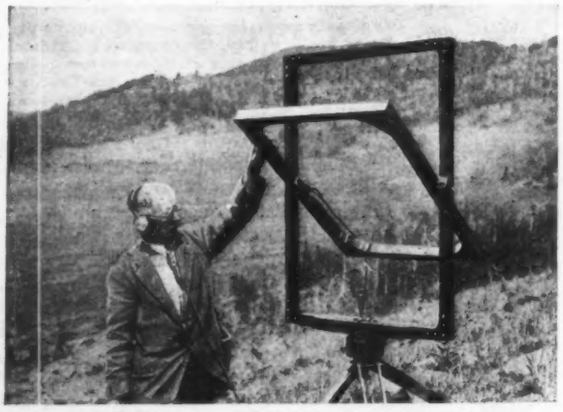
Hidden ore deposits are better conductors of electricity than the rock and earth that surround them. In that fact lies the whole secret of electrical prospecting. As expected by Dr. A. S. Eve and Dr. D. A. Keyes, who headed the exploring party, charts plotted from the headphone man's findings showed that the underground electric currents traveled in crooked, curving paths from one wire to the other. From these charts they mapped the probable location of an ore body that would play such tricks upon an electric current.

THEN they compared the mythical ore body on their map with an actual deposit of magnetite, a rich iron ore, which a laboriously executed map of the U. S. Geologic Survey showed to exist in that locality. The two maps agreed exactly upon its location. In a few hours' time the Bureau of Mines experts, without even scratching the surface of the soil, had charted a vein of iron ore that the U. S. Geologic Survey had taken months to map.

The same electrical apparatus will detect gold, silver, copper, or practically any metallic ore that is a good conductor of electricity. Copper was located in another electrical test at Ward, Colo., a few miles from the scene of the other experiments. Also, the prospectors found that certain sulphide ores of copper and iron—and there are other sulphide ores of more precious metals—are themselves natural storage batteries, generating faint underground currents that lead to their detection.

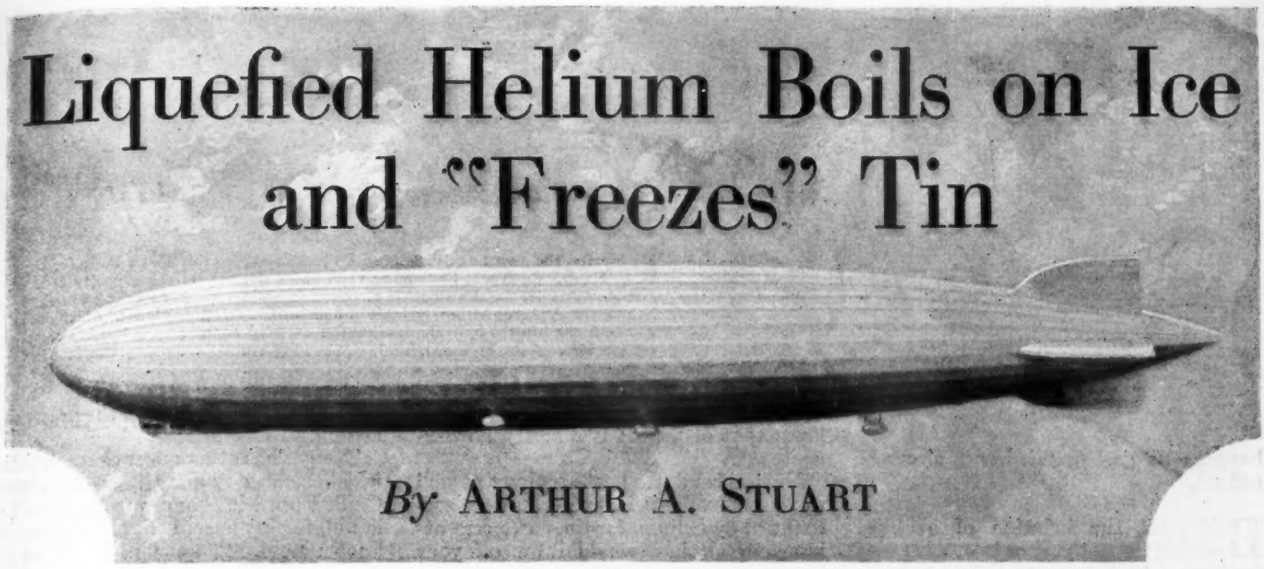
THE experimenters tried a half-dozen varied "hook-up" methods before they left Colorado. A "Pittsburgh coil" and a "leapfrog method" of electric ore-detecting were two novel developments.

The Pittsburgh coil, a sort of square looped aerial of their own invention, replaced the man with the headphones. It was not connected to the earth, but was swung about like (*Continued on page 133*)



The "Pittsburgh Coil" devised by Bureau of Mines experts to prospect for buried ore. Like a radio direction finder, it can be turned and tilted in any direction. When no hum is heard in the headphones, direction of coil indicates position of ore.

Liquefied Helium Boils on Ice and "Freezes" Tin



By ARTHUR A. STUART

Only America has enough helium to inflate its airships with the noninflammable gas.

A FEW weeks ago the little Navy blimp J-3, descending to its hangar at the Lakehurst, N. J., air station, ran afoul a weather vane. With a ripping noise her gas cells parted, and 25,000 cubic feet of helium gas disappeared to wander about among the elements, perhaps for ages before being captured and put to work again.

Only ten years ago that little mishap would have cost the Navy approximately thirty-six million dollars. In fact, helium then, little known outside the laboratory, was so rare as to be virtually priceless. All lighter-than-air craft — German, British, French, Italian, and American—were filled with the highly inflammable hydrogen gas. Yet today the loose change in your pocket might buy a barrel of helium, a cubic foot costing only about three cents.

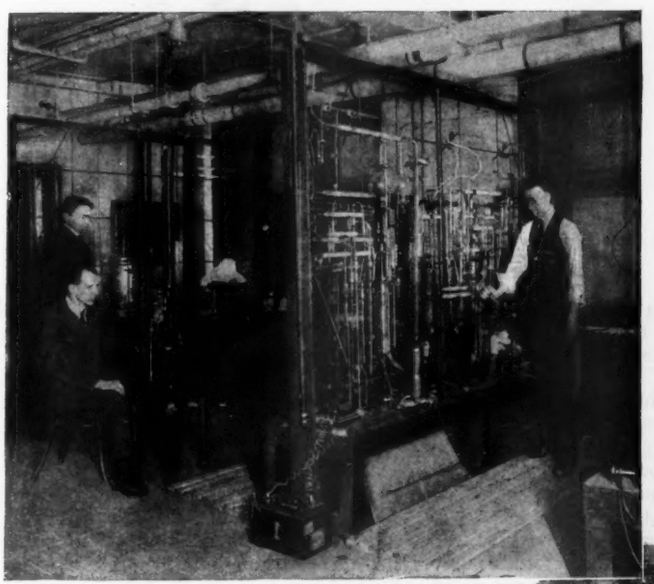
For within the last few years new fields of natural gas, from which come high percentages of helium, have been discovered and new and cheaper methods of extracting it have been developed. It is said, for example, that the new plant near Amarillo, Texas, in which the Government is at the present time installing machinery, can supply the entire needs of the United States for many years to come.

AND the United States is the only nation having, so far as anyone knows, any considerable quantity of helium. It is an all-American product. Practically the world's entire supply—which is to say, the United States', for its export is forbidden by law, as an American firm found out when a Canadian University and a Czecho-Slovakian scientist wanted supplies—comes from the natural gases of Texas, Oklahoma, and Kansas.

Helium, named from the Greek word "helios," meaning "the sun," is a colorless, odorless, tasteless noninflammable gas with about 92.5 per cent of the lifting capacity of hydrogen, the lightest gas known. It was first discovered in the sun by means of the spectroscope, in 1868, and discovered on the earth, in supposedly infinitesimal quantities, in 1895.

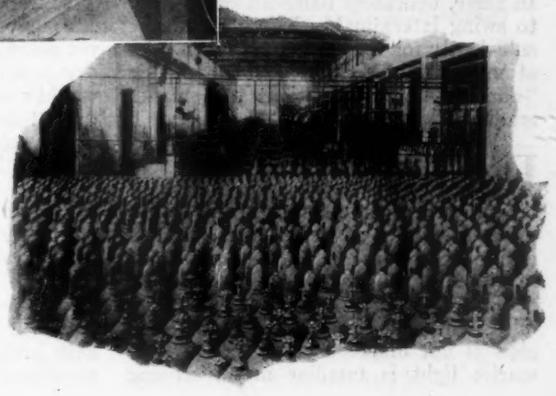
Because of its lightness and noninflammability, its chief use has been to fill the gasbags of balloons and airships. A dirigible filled with it cannot be shot down in flames, nor is there danger of a disastrous explosion set off by motor exhaust, ignition sparks, or a carelessly lighted match, as is the case with a hydrogen-filled airship. Some appalling examples of this danger are very well known.

WHEN the giant dirigible *Graf Zeppelin* made its recent flight from Germany to the United States, smoking was forbidden. No food was cooked. Precautions were taken even against the flashing of a tiny spark from a tack in the heel of a passenger's shoe by contact with metal in the ship's deck. At the Lakehurst, N. J., landing field every spectator was handed a printed request not to smoke, even in the open air. The huge silk, rubber, and metal sausage was filled with hydrogen, probably the most highly inflammable substance known. A chance spark might have caused a great catastrophe. Meanwhile the *Los Angeles*, pride of the Navy, nestled safely in its

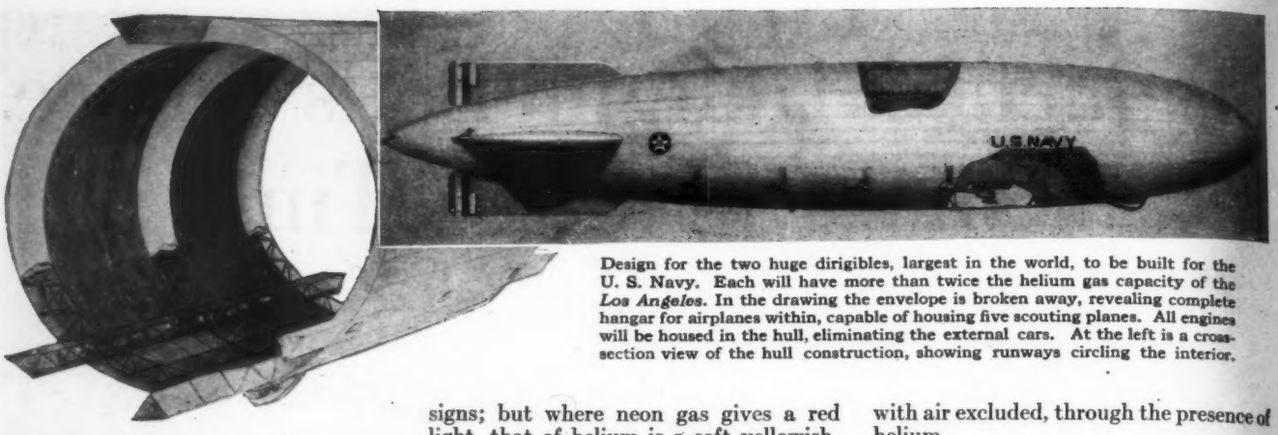


Part of Uncle Sam's helium laboratory in Texas, where experiments have developed new and cheaper methods of extracting this valuable gas.

Below: Hundreds of small cylinders of helium waiting shipment. It took 13,000 of these to fill the *Shenandoah* at her first inflation.



HERE is told the story of the strangest gas in the world. First found in the sun and used mostly to inflate airships, it is now proving valuable in radio, deep-sea diving, lighting systems, metallurgy, medicine, and for toilet preparations. Its price, once prohibitive, has been reduced to almost nothing. Mr. Stuart tells how, in a few years, scientific experiment and discovery have brought an almost priceless rarity into everyday uses for mankind.



Design for the two huge dirigibles, largest in the world, to be built for the U. S. Navy. Each will have more than twice the helium gas capacity of the *Los Angeles*. In the drawing the envelope is broken away, revealing complete hangar for airplanes within, capable of housing five scouting planes. All engines will be housed in the hull, eliminating the external cars. At the left is a cross-section view of the hull construction, showing runways circling the interior.

hangar—its gasbag filled with fireproof helium.

BESIDES the inflation of airships, within the last year or two, other uses for helium have come to light. Helium, it has been found, will prevent the "bends" or caisson disease that affects deep-sea divers. It is used in metallurgy, fills radio tubes and glow lamps, and finds a place in nautical and other scientific instruments. It cools electric transformers and high-speed generators. It is an important aid in chemical drying plants, and assists in the manufacture of cold cream and shaving soap.

Helium is the least soluble of all gases in water or other liquids—a marked contrast, for instance, to the carbon-dioxide "fizz" of charged water. It is this property that makes it a boon to deep-sea divers. The excessively painful cramps or "bends" felt by a diver emerging too suddenly are believed due to bubbles of nitrogen gas, normally a part of the air, which are forced into his blood under high pressure and cause acute distress when they froth out as he reaches the surface. Since helium will not dissolve in the blood, an oxygen-helium mixture is supplied to the diver instead of air, and experiments indicate that the menace of the "bends" is ended.

Helium is insoluble, too, in molten metals, a fact that makes it a valued tool of metallurgy. Helium, although lighter than air, is stickier. This peculiarity makes it ideal for filling the interior of nautical and other scientific instruments. In these, delicately balanced parts seem to swing interminably before they slow sufficiently for readings to be taken. An atmosphere of helium instead of air "dampens" the vibrations and makes reading easy.

RADIO tubes and glow tubes such as are used in television are filled with helium gas, in the first instance because of its usefulness in permitting electrical current to pass in one direction only, and in the second, because of the brilliant glow produced by an electrified tube filled with low pressure helium. This glow is not unlike that of neon, whose scarlet light is familiar in advertising signs; but where neon gas gives a red light, that of helium is a soft yellowish-white.

Helium conducts heat six times as well as air; you would shiver if you were surrounded by helium, for the gas, permeating your clothes, would draw off your body's warmth in no time. Moreover, it has a high specific heat, which means that it can absorb much warmth without itself rising appreciably in temperature. These facts, coupled with the advantage that it is a poor conductor of electricity and therefore proof against short circuits, make it an excellent cooling blanket for high-speed dynamos, and a safe substitute for oil as a contact breaker in transformers.

Newly designed helium tank car, consisting of three tanks forty feet long and five feet in diameter, containing helium under pressure. Twelve of these carloads will fill the *Los Angeles*.

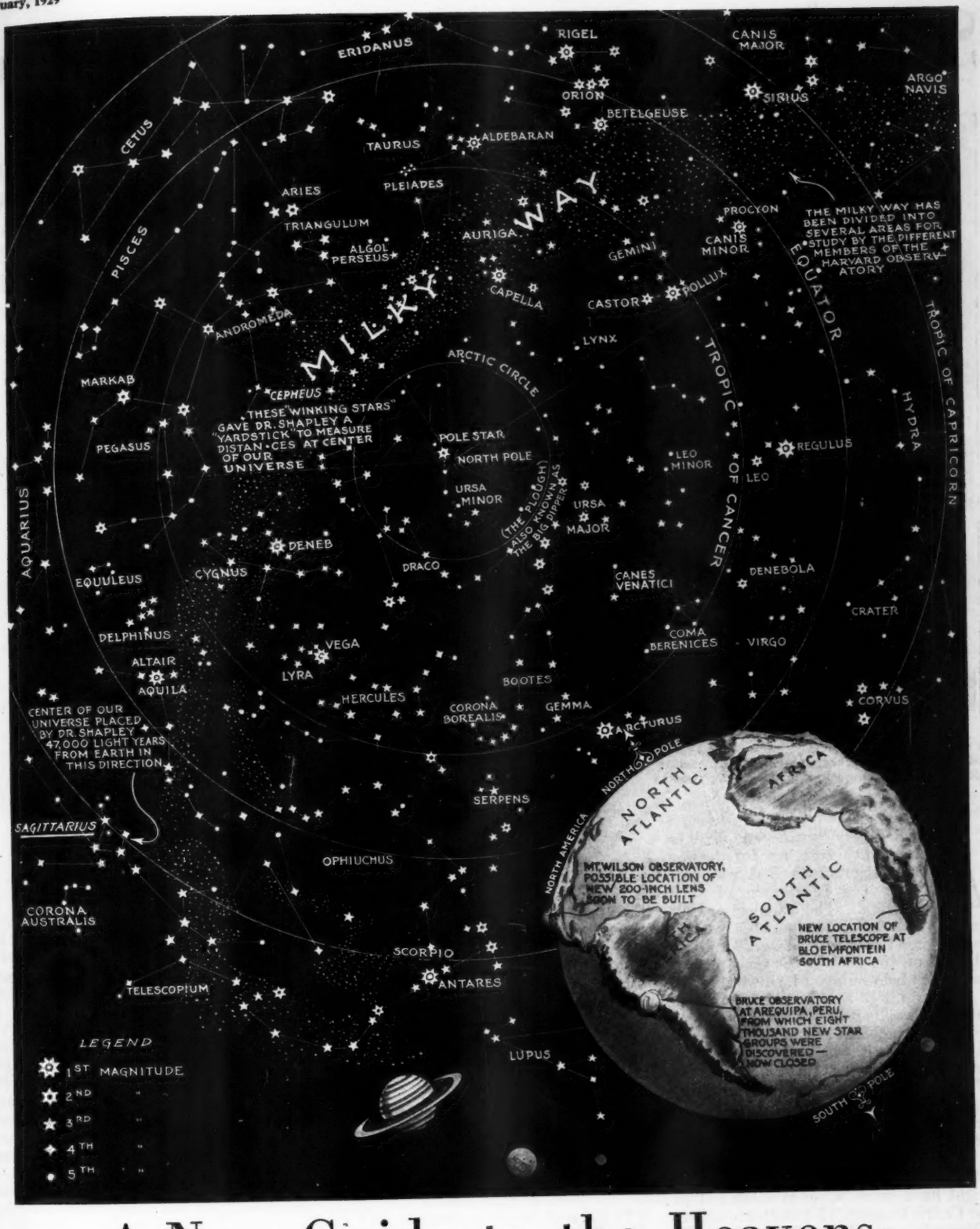
DRYING operations are sped by the use of helium. Although it is not yet practicable to hang up your wash to dry in a tank of helium gas, the clothes would come out moisture-free in double-quick time. The reason is that water and other solvents evaporate much more speedily in helium than in air. Practically this is important in chemical factories, where trays of chemicals are efficiently dried under air-free hoods containing helium.

In the manufacture of toilet preparations, such as shaving soaps and cold cream, helium recently has proved valuable because of its insolubility, already mentioned. Soaps and pastes are mixed with air excluded, through the presence of helium.

The gas has other queer characteristics, which some day may be put to work. Chilled until it changes from a gas to a liquid, for instance, helium is the coldest known fluid. It liquefies at about 450 degrees F. *below* zero, and has been chilled by Prof. Kamerlingh Onnes, at Leiden, Holland, to the coldest temperature ever produced by man—457 degrees below zero, or within two degrees of that "absolute zero" that physicists call the rock bottom of the temperature scale. Some of this super-chilled helium, dropped in the middle of the south polar ice sheet for which Commander Byrd and his exploring party are heading, would boil like water on a red-hot stove. At its temperature a tin cup becomes brittle as glass, and mercury freezes so solidly that you could make it into a hammer head that would drive a nail. Only by immersing other substances in liquid helium can they be made as cold; no other substance has its chilling power.

A LONELY stranger is helium among the chemical elements, and only once has it been suspected of entering into combination with one of them. Prof. Karl T. Compton, of Princeton University, has reported that it will combine with mercury in a vacuum tube, when the mercury has been rendered active by invisible ultra-violet light.

Perhaps these properties will suggest new uses in time. One thing is certain—that none of them will equal in novelty some of the entertaining suggestions that have been received by the trade research department of a commercial helium company of Dexter, Kansas. A St. Louis inventive genius had an idea for a crashless airplane. If the motor failed, a tank of highly compressed helium on the under side of the fuselage was to support it in the air—only it wouldn't. Next came a man with a talent for advertising. He proposed to make and sell gaudy painted windmills, whose whirling blades were to attract attention to the advertising placard they bore. The only trouble was that the wheel bearings had a way of wearing out. Wouldn't a little tank of helium—about the size and shape of a quart mason jar, he suggested—suspend the windmill (*Continued on page 130*)



A New Guide to the Heavens

IMAGINE a giant disk wheel whirling in space. That is our universe as astronomers now picture it. Dr. Harlow Shapley, director of the Harvard College Observatory, Cambridge, Mass., has just announced that, 47,000 light years distant in the direction of the constellation Sagittarius, he has discovered the central hub about which it spins.

This hub he estimates to be 29,000 light years across and 16,000 light years thick. A light year, the distance a beam of light will travel in a year, is about six trillion miles. For his measurements, Dr. Shapley used as a yardstick the Cepheus variable stars—"winking stars" whose changes in brightness permit complicated astronomical calculations of their distance from the earth.

Dr. Shapley also reports the discovery of 8,000 spiral nebulae, each believed to be a universe like ours, revealed by photographs made at the Harvard Observatory in Peru. The total number of these "island universes" is estimated by Dr. Edwin Hubble, of Mt. Wilson Observatory in California, at ten million; somewhere in space, astronomers believe, is a center of centers about which they spin.

Above our artist has charted the important stars and groups of stars in our universe. You'll find the drawing unusually helpful in identifying the stars.

S O S!—A Challenge to Science

© 1928, Pacific and Atlantic Photos, Inc.

A tragic scene on the careening deck of the *Vestris* just before she sank—Inexperienced seamen, wearing life belts, struggle frantically to launch the ship's boats.

HELPLESS women and children in battered lifeboats, dangling at the steel side of a sinking ship, doomed to be swallowed in the sea! Who, after the investigations that followed the tragedy, has not been stirred by the verdict of marine experts that "it could have been prevented!" Here is told how inventors are answering the *Vestris* challenge.

By FREDERICK TISDALE

Our artist here pictures the difficulty of launching lifeboats from the high side of a heavily listing vessel. The descending boat must scrape against steel plates of the steamer's hull, chancing breakage or upsetting, with loss of life.

AFTER every great sea disaster humanity searches for devices and regulations that will prevent the recurrence of such horrors. The Lamport & Holt liner *Vestris* sank two months ago off the Virginia Capes with a loss of 111 lives. She lies on the floor of the Gulf Stream two miles below the surface white caps.

As a result of searching investigation into this disaster it becomes apparent that if similar tragedies are to be prevented in the future, it will be because of the progress of science and the achievement of invention. Old, outmoded life saving equipment must be discarded or improved; new contrivances created and perfected.

A new type of lifeboat, recently exhibited and tested in London, for example, might have saved some of those lost in the *Vestris* tragedy. This craft, reversible, self-emptying and unsinkable, is somewhat similar in appearance to the ordinary lifeboat. But a cross-section resembles a shallow letter "H" and the upper and lower portions are identical in construction. Thus, the boat is still a boat when it upsets! In addition, it is made self-emptying by a system of non-return valves that operate no matter what side happens to be uppermost. Sealed airtanks give it buoyancy and keep the deck-level always above the water line.

In tests at the London docks, one of the boats, capable of holding sixty people, was loaded with 180 sandbags to represent their weight. First, the non-return valves were stopped up and three tons of water pumped into the boat. The gunwale remained well above water level. Then the valves were released and the vessel emptied itself in a little over one minute! To simulate lurching in a stormy sea, the sandbags were transferred, one by one, across the boat until one side was light and the other fully loaded. Still, the gunwale remained above water. An ordinary lifeboat, put to the same test, began to sink after the seventh sandbag had been carried across!

EVEN such boats, however, would not solve entirely the problem of safety at sea. One of the greatest difficulties lies in the launching of lifeboats in the hour of peril. The trouble is that many seamen no longer are sailors.

In the good old days of the clipper ships—of "wooden ships and iron men"—crews consisted of fellows who were past masters in handling ropes, oars and tackle. But modern steamers are really intricate collections of marvelous machinery, and the men who work them, many of them sea-going hotel men, have no need, under ordinary conditions, of skill in seamanship. And difficulties in the lowering of lifeboats today are intensified by the fact that the deck of a passenger vessel may be sixty feet above the water—the height of a six-story building!

THE fact that few women and no children were rescued from the *Vestris* testifies to the failure of life saving equipment. Pictures, raw and vivid, leap out of the tales told by survivors, emphasizing the defeat of mechanics and sailors by the deadly force of the ocean.

A fireman, Boxill, testified that he took his station in a lifeboat filled with passengers. The boat was lowered part of the way—and stuck. He and another member of the crew stood with drawn knives waiting for the order to cut the gear and release the boats. The *Vestris* rolled over while the boat swung in mid-air, spilling the passengers into the water. Boxill swam to a piece of wreckage.

"There were some dead children and women around there, sir, and that got me kind of dizzy. I . . . swam off."

Charles W. Johnston, a passenger, saw two boats hanging to the ship, loaded with women and children, when she

went down. A member of the crew said that a boat stuck on the side of the *Vestris* instead of sliding into the water. Two members of the crew cut away the ropes with knives, but the line at one end parted first "and emptied everybody into the water." Another struck something and was launched with a hole in her side.

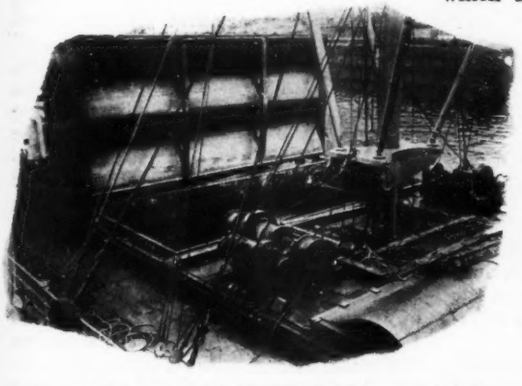
THE sad inventory of these boats illustrates one great difficulty encountered in a sinking ship. Rarely do stricken vessels go down on an even keel. They list—or lean—either to one side or the other. This lifts the high edge of the boat deck away from the water and places the side of the ship below the lifeboat. When the lifeboat is lowered it must scrape the parent vessel's hull as it descends and this hull is a series of irregularities where the steel sheets overlap, and where rows of rivet heads protrude. On the other hand, the list places the opposite side of the deck nearer the water and makes it easier to lower the boats there since the drop is unobstructed.

The *Vestris* had a starboard list. In landlubber English, that means she leaned to the right. This brought the starboard boats close to the water and lifted the port or left side boats high in the air, placing the ship's hull below them. It was in the lowering of the port boats that the disaster struck most heavily.

But science and invention have begun to solve the problem of lowering boats quickly in emergency. The latest and finest devices for handling lifeboats are to be found on the new steamships of at least one line operating from New York. Small electric winches lower and raise the boats. An equalization device keeps the small craft on an even keel as they drop toward sea-level.

ONE of the loudest public outcries usually heard following shipwrecks is to the effect that the wooden lifeboats leaked. And in that connection the owners are accused of culpable thrift.

Such complaints are due to a popular fallacy. As a matter of fact, a wooden boat is more expensive than one of steel.



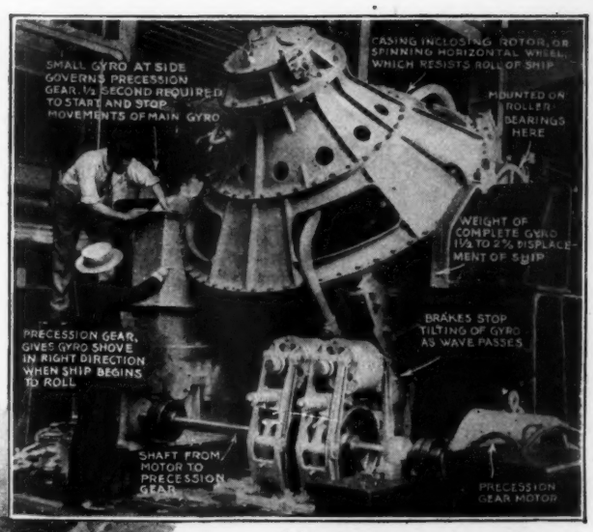
A new safety substitute for the usual heavy, awkward wooden hatch cover. This hinged cover of light, strong metal, can be closed quickly and easily if a storm rises.

In addition, certain countries, Great Britain among them, require the use of wooden boats. Why? Because experts agree that they are better. The best materials are spruce and pine. The finest type is clinker built, that is, from planks that overlap each other. The objection to metal boats is that they are not as strong. Any smashing or denting upsets their equilibrium and when punctured they are hard to repair.

Latest device for launching lifeboats. Mechanical arms swing well out over the side and keep the boat on even keel as it is lowered by powerful electric winches.

Rafts are another form of safety equipment upon which inventors are concentrating. Many important passenger ships today carry one or more liferafts made of balsa, the lightest of all woods. The balsa tree, which grows in the mountains of Bolivia around the shores of Lake Titicaca, is lighter than cork. Radio fans have become familiar with its wood, which has been used in making loud speakers. One or two liferafts of balsa wood might have helped save some of the women and children of the *Vestris*.

The best type of liferaft, marine authorities agree, is the catamaran. It is kept afloat by two long pointed air-filled metal cylinders. Between these is a wooden platform for the passengers. The finest have copper cylinders, to prevent rusting, and they are divided into compartments so that, if one section is damaged, enough air remains in the others to keep the craft afloat. There are rowlocks for propulsion and steering. The tops and bottoms are alike, as in the case of the lifeboat, described above, so that it makes no difference how the raft strikes the water.


SMALL GYRO AT SIDE GOVERNS PRECESSION GEAR. ½ SECOND REQUIRED TO START AND STOP MOVEMENTS OF MAIN GYRO
CASING INCLOSING ROTOR, OR SPINNING HORIZONTAL WHEEL, WHICH RESISTS ROLL OF SHIP
MOUNTED ON ROLLER BEARINGS HERE
WEIGHT OF COMPLETE GYRO 1½ TO 2% DISPLACEMENT OF SHIP
BRAKES STOP TILTING OF GYRO AS WAVE PASSES
PRECESSION GEAR, GIVES GYRO SHOVE IN RIGHT DIRECTION WHEN SHIP BEGINS TO ROLL
SHAFT FROM MOTOR TO PRECESSION GEAR
PRECESSION GEAR MOTOR

Science's answer to the problem of preventing serious lists such as proved the *Vestris*' undoing. The whirling flywheel of this stabilizing gyroscope will bring a ship back on an even keel, even if the cargo shifts.

Science, too, already has answered the question: How is it possible to prevent lists such as proved the *Vestris*' undoing? Some day, I believe, every ship carrying passengers will be equipped with stabilizing devices which will keep her on an even keel and bring her back even if her cargo shifts. Already many yachts and a few naval craft are so equipped. The gyroscopic stabilizer is the device that does the trick. A gyroscope is a flywheel mounted so that it is free to revolve in any direction. Make it big enough, heavy enough in the rim and it will resist every effort to tip it out of its original plane of rotation. Some large yachts that have stabilizers ride with decks as level as a ballroom floor through storms which would set the greatest liners rolling. One Japanese cruiser was brought from a thirty-degree roll to an even keel in a few seconds by means of the gyroscope.

LIFE-BELTS of a type far superior to the standard "vest" type many passenger boats are still carrying, and which were carried by the *Vestris*, now are available. This type of belt makes it almost impossible for the wearer's head to be submerged. One may go to sleep in the water without danger of drowning, while with the ordinary life-belt constant effort and wakefulness are necessary.

Meantime marine engineers and architects of all seafaring nations consider the perfecting of the unsinkable vessel their greatest and most pressing problem. When this goal is reached and inclusion of the latest safety-devices in ships' equipment is compulsory, science and invention will have accomplished their purpose of relegating ocean disasters to the past.

If You Had Millions to Spend—

Two flying laboratories of the Guggenheim Fund, piloted by veterans, carry on experiments to conquer fog on airways.

WHAT would you do? Harry Guggenheim chose to go in for aviation. He marshalled the forces of science to conquer the flyer's deadliest foes, and to make airplanes as safe and useful as automobiles. Here is the story of a twentieth-century pioneer, a man who looked into the future. It forms a stirring episode in the drama of the air.

By MICHEL MOK

A FEW weeks ago a new research laboratory was added to the world's gallery of modern scientific developments.

It is a laboratory without test tubes, retorts, microscopes, and Bunsen burners, and without learned looking men using these intriguing paraphernalia for purposes of minute investigation.

This new "research bureau" hurtles through space. It consists of two airplanes. The "professors" in charge are experienced aviators. And its aim is the ultimate defeat of the flyer's most dangerous enemy—fog!

Equipped with a wealth of instruments, the unique flying laboratory conducts its experiments on a section of an established airway in the East. Here a thorough study of fog flying is made under regular operating conditions.

Hope runs high that, as a result of this practical pioneering work, the airman's worst foe will be beaten to a standstill at last.

The flying laboratory was conceived and established by the Daniel Guggenheim Fund for the Promotion of Aeronautics. It is the latest in a series of valuable contributions toward the progress of aviation made by the organization which is probably doing more than any other agency to hasten the day when all the world will be on wings.

THE Fund has set itself the task of making aviation safe for humanity and humanity receptive to the benefits of aviation. This program it carries out in a thoroughly practical way. It has endowed special schools of aeronautics in some of our leading colleges and universities. It planned and financed Lindbergh's celebrated nation-wide tour. It conducts experiment and research activities. It organizes international movements designed to promote the safety of flying. Just now it is engaged in a nation-wide campaign to have the towns and cities of the country identified by roof-marking for the guidance of the airman. In brief, all of its activities are directed toward the perfection of aircraft and toward the development of that attitude of public confidence toward aviation which has come to be known as "airmindedness."

Somebody once aptly said that every institution is but the lengthened shadow of a man. Eager to measure the stature of the personality behind an organization that is preparing a way through the clouds for you and me, I sought the headquarters of the Guggenheim Fund.

There, in an unostentatious office, unencumbered by fancy-titled assistants, expensive furniture, or red tape, I found Harry F. Guggenheim, president of the Fund.

Names often have a way of subtly suiting their bearers. The friendly informality of this man's first name fits him like a glove. About forty, blue-eyed, tanned of skin, well set up and proportioned, and the possessor of a ready, engaging smile, he is the kind of chap who is likable at first sight, because he combines inherent dignity with a deep-seated, genuine interest in his fellows that is betrayed in almost every word and gesture.

At once I understood how he must have appealed to Lindbergh, his sworn friend, from the moment Guggenheim, then a total stranger, shook his hand and wished him "Safe landing!" the day before he set out on his epic trans-Atlantic flight.

Daring pilots are trying to solve the problem of overcoming perils of sleet storms which cover airplane wings with icy weight.

In the course of our chat, I caught the color and outline of a strong, rich personality, one that shapes dreams into deeds; that bridges the gap between the philosopher and the organizer, the scientist and financier.

"The first word in aviation has hardly been spoken," he told me; "but you and I will see the day when the average man, and woman, too, will fly with the same comfort and safety they enjoy driving around in their automobiles today."

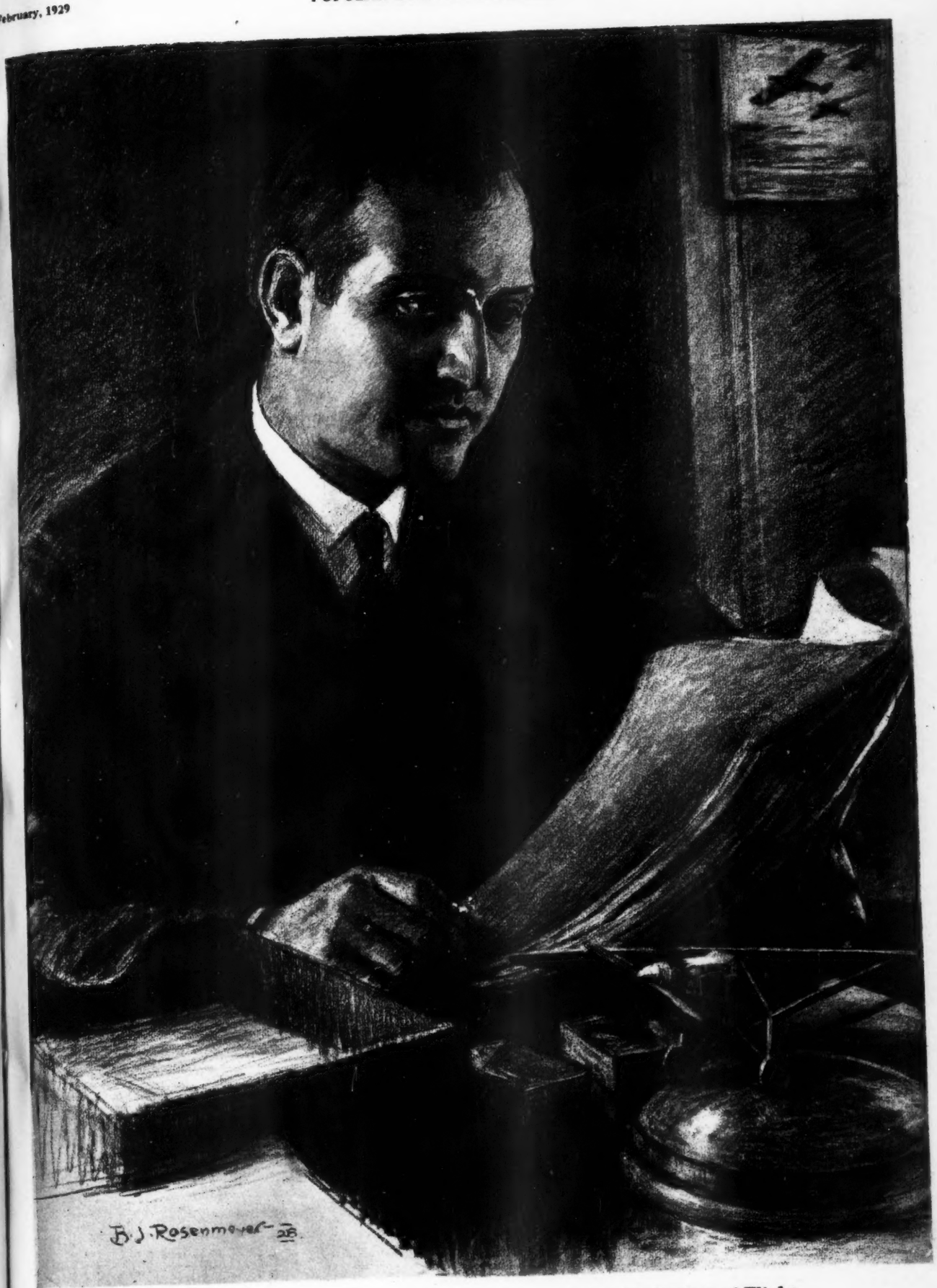
There are many who share that vision, and many more who still scoff at its mere mention. But this man gives without stint of his time and his talents to bring about a quick realization of the old dream of breaking the ties that bind humanity to earth!

I SOON found out why. To Harry Guggenheim, airplanes are the harbingers of peace, the instrumentality that eventually will bring about a true and lasting sympathy among the nations. This underlying sentimental reason for his absorbing interest in aviation he revealed when I asked him what he considered the greatest single contribution the airplane had made to modern progress.

"Its annihilation of space," was his quick reply, "and through that, its establishment of closer communion between various communities. At one time, not so long ago, the populations of our East and West were practically two different peoples because of the distance that separated them. They had their own customs, traditions, viewpoints, and aspirations. The railroad came and did much to improve that situation. The airplane is doing and will do the rest! The next step will be the binding together of nations, with the thorough understanding of each other's ideals, needs, and problems that is bound to follow."

Curiously enough, Harry Guggenheim originally saw the potentialities of the airplane as a powerful ally of peace and progress when a pilot during the World War.

As a boy, he had spent one term at the Sheffield Scientific School at Yale and had worked in the mines and smelting plants of Mexico for the American Smelting and Refining Company, one of the concerns controlled by his father's firm. Later he got the degrees of Bachelor and Master of Arts at Cambridge University in England. There he (*Continued on page 162*)



Harry F. Guggenheim, Godfather of Flight

As President of the Daniel Guggenheim Fund for the Promotion of Aeronautics, he has taken the lead in making air travel safe for everyone. "The first word in aviation," he says, "has hardly been spoken."

Drawn from life especially for POPULAR SCIENCE MONTHLY *by B. J. Rosenmeyer*

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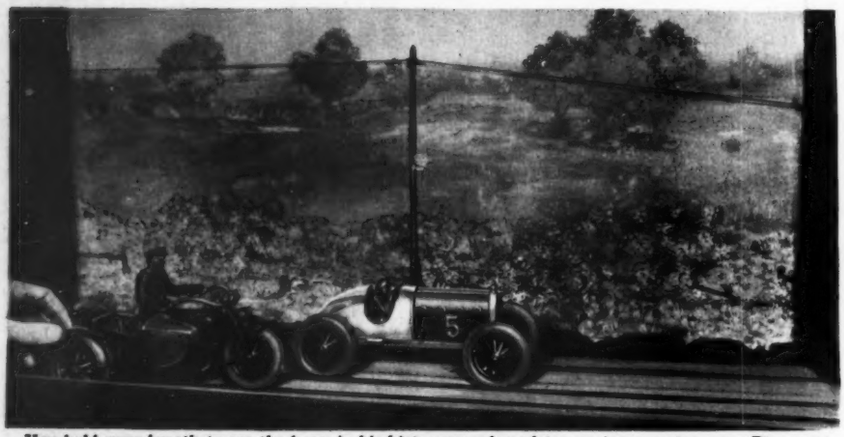
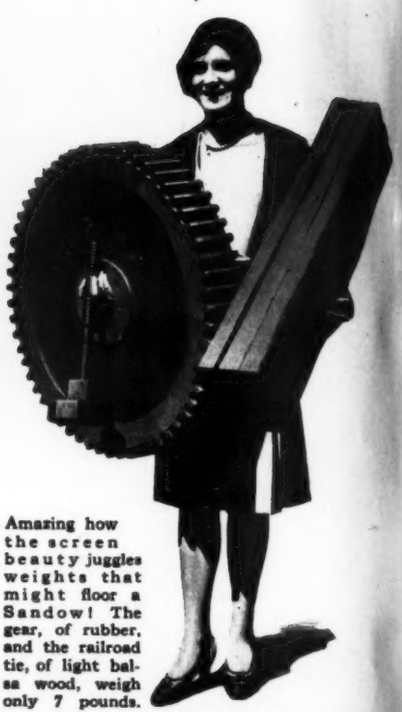


You hold your breath to see the hero, in his high-powered roadster, racing a motor cop. The scene is filmed with tiny model cars, standing still. A moving back drop gives the effect of high speed.

Making Movie Thrills with Tiny Toys

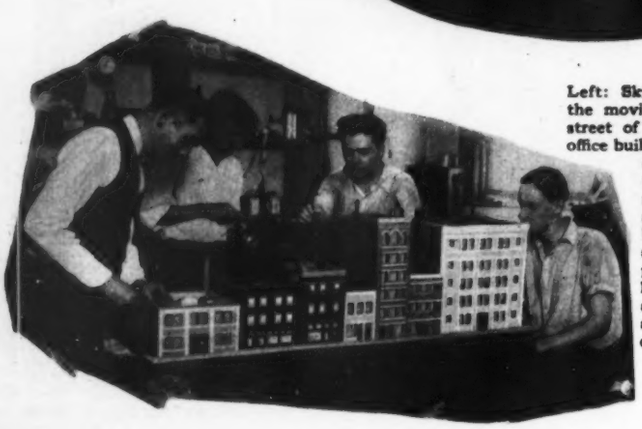


Amazing how the screen beauty juggles weights that might floor a Sandow! The gear, of rubber, and the railroad tie, of light balsa wood, weigh only 7 pounds.

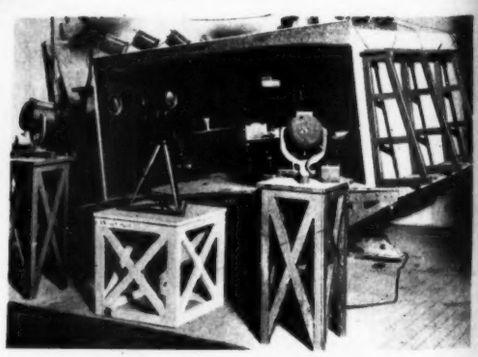
On the screen it looks like a sure-enough ocean liner, tossed by a real hurricane in mid-Atlantic. But in the studio where the picture was made the liner was a model ship bobbing in a tank no larger than a bathtub. It was rocked and tossed about by a wave-making mechanism operated by a small electric motor.

A remarkably faithful model of the city of Detroit, used in a movie thriller. The figure of the hero, superimposed, appears to do breath-taking stunts atop a tall building.

Remember how Douglas Fairbanks rode the magic carpet through the air in *The Thief of Bagdad?* Well, it wasn't Doug at all. The riders were puppets, and the toy carpet was manipulated by wires.



Left: Skilled toy makers of the movies, constructing a street of model stores and office buildings, smaller than doll houses. Photographed at close range, they appear as real, full-sized buildings on the screen. By trick photography, the human figures and action of the drama are superimposed on this setting.



This miniature ship captain's cabin, rocked by motors, serves as the setting for an exciting mutiny in a storm. Depicted on the screen, the lurching room seems real enough, with action superimposed.

It's a long way down, and no elevator. Here Mrs. Williamson is entering the flexible steel tube that leads to the camera "studio" on the sea floor.

Taking notes on the drama of the deep. Just beyond the heavy glass window is a frolicking school of curious "sergeant-major" fish, so-called because of their stripes of black and gold.

Dry and safe in the camera chamber, Mrs. Williamson watches a native diver outside the window pluck a sea-fan of lacelike beauty.

Ringside Seats on the Ocean Bottom

How the deep-sea chamber works. Observers descend by ladder through a steel tube, hung from the ship.

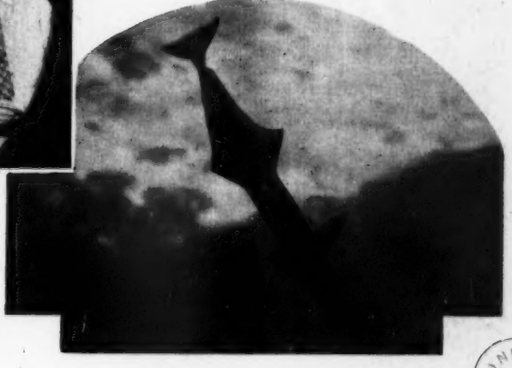
A VICIOUS shark prowls along the sea bottom hunting for prey. Stealthily on his trail glides a monster sucker fish, bent on attaching himself like a parasite to the undersea destroyer. This and other thrilling dramas of the deep are revealed in remarkable photographs snapped recently at the sea bottom off the Bahamas by J. E. Williamson, pioneer undersea photographer, and Mrs. Williamson.

Their camera studio at the ocean's cellar is a globe-shaped steel chamber fitted with a window of massive glass. It hangs from a cruising ship by a flexible, hollow shaft of steel that stretches like an accordion to form a veritable "hole in the sea."

This weird contrivance was invented years ago by Charles Williamson, father of the photographer, for deep-sea salvage. The younger Williamson and his bride have adapted it as a movie studio, and as a chamber from which divers emerge to gather specimens of coral.

A prowling beast of the deep. This remarkable photograph of a shark hunting its prey along a coral reef was snapped by Williamson from the diving chamber.

The photographer and his wife in the cozy chamber. At the left is a water-tight door through which divers can pass. Note headphones.



Right: Action photo of an unusually large sucker fish that lives by attaching itself to a shark and snatching food away from its host.

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One Jump Ahead of Death!

A thrilling sport for the sure-footed. Crossing a narrow ice ridge atop Mt. Robson in the Canadian Rockies.

A great playground for mountain climbers—the challenging peaks of Eiger and Jungfrau in Swiss Alps.

Will he make it? This climber risks a flying leap across a 12-foot gap on the Matterhorn.

Almost straight up! Roped together, Alpine climbers scale sheer walls of rock, struggling for toe-hold on the mountain's rugged face.

Would you like to be in his shoes? It takes a real athlete to cross a treacherous "chimney" in the wild Grison peaks of the Alps.

In the game of tag with death, every mountain climber finds his reward in the thrill of reaching his goal at the tip-top after a perilous ascent. The view above shows a conqueror of one of the towering pinnacles in the Swiss Alps, roped to a comrade just below.

Somewhere, high on the Matterhorn, a mountain climber is lost. A searching party sets out in the night, carrying flaming torches to light their difficult way over the treacherous ice.

Where one misstep may mean a plunge of hundreds of feet into the depths of a yawning crevice. Here two climbers stand at the brink, deciding whether to try the crossing.

Strange Sights Snapped By Our Camera Men

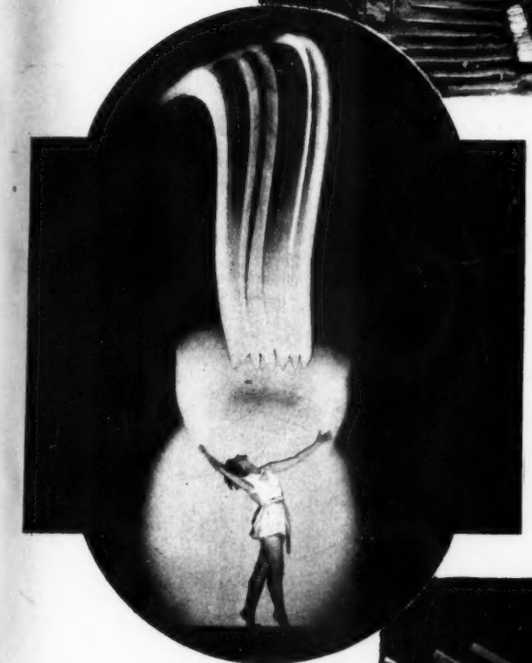
Left: Interior of one of the up-to-date cavern homes of Troo, showing comfortable furnishings and clean rock walls. Even here electricity serves the housewife.

Modern Cave City

Cave dwellers, whose homes in the cliffs are equipped with electricity and other modern conveniences, form one of the strangest villages in the world, called Troo, on the banks of the Loire River, southern France. At the right is the main street of the village—a stairway up the face of the cliff. It leads past the entrances to homes carved from rock wall.

This Dentist Had Courage

Olga, the leopard, had a jumping toothache, and kept the other inmates of a Los Angeles zoo awake of nights. So her trainer, a young woman, took the beast to a courageous dentist, placed her in the chair, and held the ferocious jaws apart while the cavity was filled. Olga jumped only once, and never growled.



Light Organ Paints Scenery

Colorful symphonies played with light instead of sound, and canvases painted without pigment, are suggested by the invention of a new light organ, called "Clavilux." One of its possibilities is the substitution of beautiful, changing color forms for costly stage settings. Above is a dancer performing before a "backdrop" of light projected from the instrument. At the right the inventor, Thomas Wilfred, is seen at the console of the new organ.

Drives Rocket Motorcycle

Speeding at thirty miles an hour over a board track, a motorless motorcycle propelled by rockets was tested recently at the Velodrome, New York City. It is said to have been the first American trial of rockets as a means of propulsion. The designer and driver of the cycle is Capt. George White, whose experiments in Florida with a wing-flapping flying machine were reported in POPULAR SCIENCE MONTHLY. He used a bank of ten rockets, mounted to fire to the rear and produce a succession of recoils to drive the machine.

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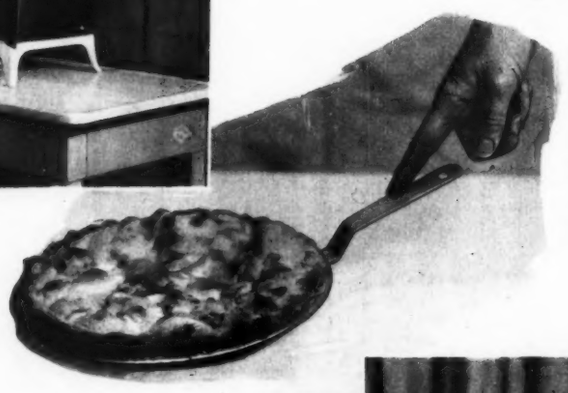
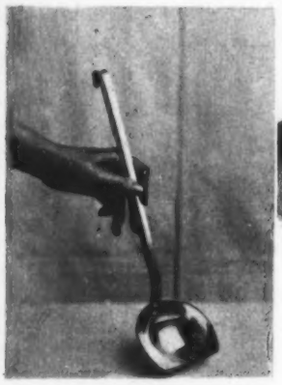
Inventions That Every Housewife Will Appreciate

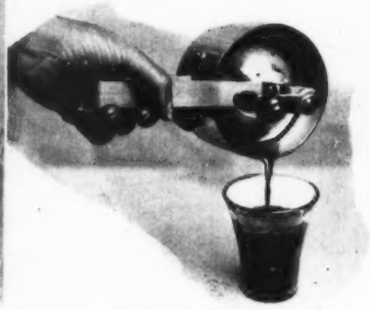
This new electric broiler is said to cook a three-pound steak in ten minutes, searing both sides at once. Place the steak in the meat grill, insert in the broiler, and close the doors. By the time you have dressed for dinner it is cooked. The device plugs into the nearest wall socket. The heating element is removable for cleaning.



Whoever thought of putting a handle on a pie pan? No doubt an inventor-housewife, who burned a finger pulling one of the old-fashioned kind out of the oven. Anyway, here it is—the pie pan with a handle—that removes fear of dropping the pie or scorching the hands when the juicy crusted pastry is done.



The straight front edge of this new aluminum ladle is designed not only to get more food out, but to scrape the pot clean. It affords a wide contact with the bottom of the pan. At the opposite end is a handy hook.

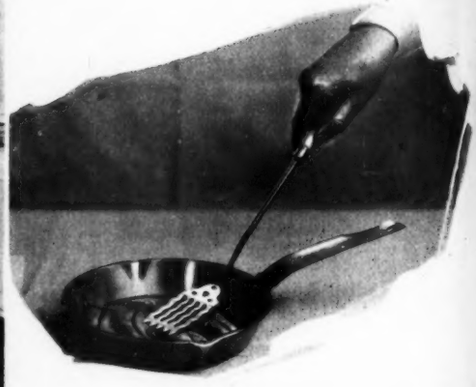


The inventor of this aluminum orange juice extractor claims it gets the last drop. A turn of the handle completely reams the fruit, and the seedless juice is poured into a glass without spilling.

A miniature thermometer built into the top of a new waffle iron saves the first waffle, according to the maker. You can't spoil any, because you simply preheat the iron until the temperature is just right—then go ahead and bake. A temperature chart tells the right heat to use to get the best results.

Push down with your finger on the cover of the novel pin holder shown below, and a pin hops out. No danger of pricking your finger, for the device puts pin in your hand head up.

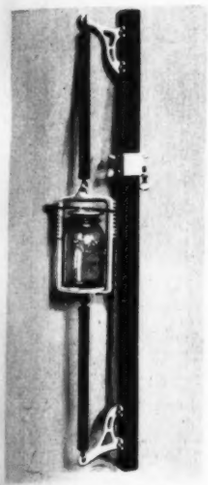
Gas range and gas refrigerator are combined in a new space-saving outfit for the kitchen. Steps are saved by the convenience of storing food near the stove; and so effectively is the cooling chamber insulated from the range, it is said, that no heat leaks through to melt the ice.



The wavy ripples of this unusual frying fork are designed to prevent bacon and other meats from slipping off as they are removed from the pan. The fork has sharp, tenacious points to aid further in handling the meats. Wide slots allow the grease to drain from the meats as they are lifted. A long handle with a wooden grip keeps the hand away from hot fat.

Set this novel egg-timing alarm clock for "soft," "medium," or "hard," and when the eggs are done the word "boiled" flashes into view in the window. A bell rings at same time as a reminding signal.

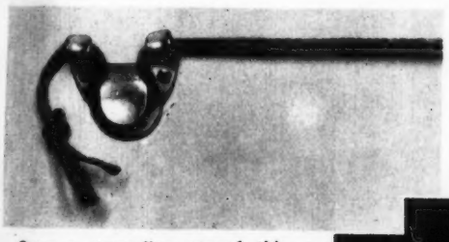
Here are two electric household novelties—a percolator that makes either tea or coffee, using special immersion heater, and a special grill for toasting sandwiches. Coffee is brewed with a coffee basket and percolator tube; for tea-making this is removed and a tea ball is hung from the top. The toaster has expanding hinges.



Two coil springs supply churning motion to mix batter or whip cream in the jar. Once started, the two springs continue the motion.

A new metal clip holds the glass percolator top from falling off when you pour the coffee. The clip fits over the knob of the glass, and is fastened in place by bending its flexible ends under the rim of the lid.

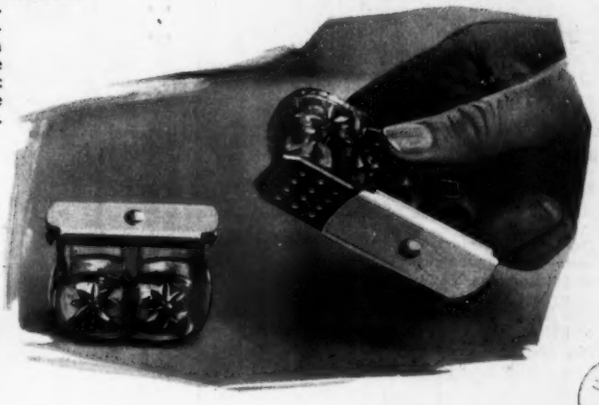
Bathroom medicine cabinets built into the wall and hid by mirror doors are a recent home improvement. Here is the newest—one with a double-hinged mirror that can be swung to any angle for the best light, or flat against wall.



Snag a clotheasline around this wall hook, and the harder you pull the tighter it grips. The rustproof holder is declared to be a positive remedy for sagging lines, and it eliminates bothersome knots.

This single electrical appliance makes the breakfast toast and coffee both at the same time. The heating element for pot and toaster are in the base of this new cooking device.

Something new in holders for metal wool, used to scour pots, is the flexible rubber handle below. Bending back the sides exposes a safety-pin catch that is slipped through the wool and hooked.



The nonspill salt and pepper shakers at the right are useful for picnics as well as at home. A sliding guard keeps the contents where they belong, and is arranged to uncover either salt or pepper.

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Men *and* Ideas Setting the Pace In Aviation

Left: Without touching controls, two pilots demonstrate remarkable stability of new safety monoplane. Note the unusual tail plane, and low main wing.

Creator of the new safety monoplane — Donald Hall, who also designed the famous *Spirit of St. Louis* for Lindbergh. In recent tests, his new ship (above) "flew itself" for long stretches up the Pacific Coast. Unusual features are its large lifting tail surface and omission of the stabilizing fin before rudder.

The latest creation of German builders is this army observation balloon, which can be converted into a controllable airship by addition of motor, stabilizing planes, and rudder. Thus the big bag can move about, independent of the usual ropes to the ground. The upper picture shows the gondola of the balloon.

Captain Boykow, German inventor, with a new gyroscope device which, he claims, will prevent gusts and bumps from tipping a plane off an even keel, and enable a pilot to fly without touching controls, once he has gained altitude. Ocean flyers Chamberlin, Koehl, and Fitzmaurice are said to have tested planes using the device.

Here's the latest view of the remarkable Slate all-metal dirigible, first of its kind, nearing completion in its hangar at Glendale, Calif. The ship, 212 feet long, has a shell of corrugated sheet duralumin. The upper picture shows ingenious elevator in which passengers are to be lowered from the hovering ship along a rope passing through center.

Three blades, instead of two, whirl at the nose of a new Boeing biplane recently tested by Erik Nelson, 1924 Army round-the-world flyer, to discover whether extra blade will increase speed and enable a plane to rise more quickly.

Climbing seven miles above McCook Field, Ohio, Captains St. Clair Streett (right) and Albert W. Stevens, U. S. Army altitude flyers, recently took photographs of the city of Dayton below. It was a record. They are shown at left with their equipment, including heating apparatus in foreground.

STRANGEST of New Fighting Planes Is an Unseen "Ghost" of the Air—Other Astonishing Inventions and Records Mark the Month's Progress in Flying

A PHANTOM airplane designed for war use and said to be practically invisible in the air is nearing completion at Nottingham, England. Recent tests showed the possibility of constructing such a plane, on which it would be impossible for enemy gunners to train artillery, as reported not long ago in POPULAR SCIENCE MONTHLY. Now the British government is building the first of these war terrors.

It is made entirely of "plass"—a material of secret composition which looks like glass, can be handled like metal, and will stop bullets. Even the pipes for gas, water, and oil are of this material. An observer seeing the machine on the ground would rub his eyes and imagine himself gifted with X-ray vision. He could see right through all parts but the motor, control stick, and wires, which are of conventional material. Against the sky, only a hum will betray the plane's approach.

More Records Smashed

NOTABLE airplane records marked the last month in aviation.

An unofficial world's record for speed went to Flight Lieut. D'Arcy Grieg, British pilot, who flew his supermarine Napier seaplane at an average speed of 319.57 miles an hour off Calshot, England, in four consecutive dashes over a standard course. Since Grieg failed to exceed the previous mark by five miles an hour, Major Mario de Bernardi of Italy still holds the official world's record of 318.62 miles an hour.

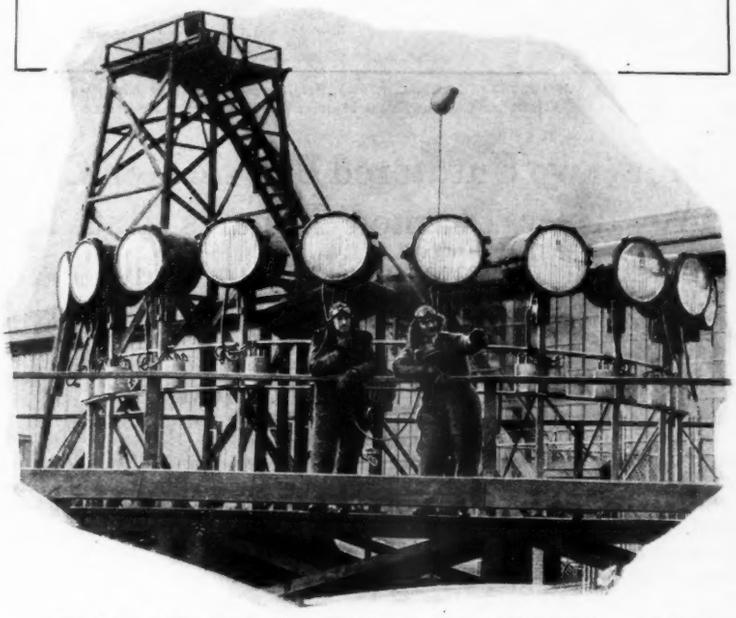
What is believed to be an unofficial speed record for commercial transport planes was set by an American passenger craft, of the Western Air Express, which averaged 177 miles an hour on a 365-mile flight between Oakland and Los Angeles.

The world's altitude record for a plane carrying two men, it was recently disclosed, belongs to the two U. S. Army flyers, Capts. St. Clair Streett and Capt. A. W. Stevens, who recently climbed to 37,854 feet—within 600 feet of the world's free-for-all airplane altitude mark—to take air pictures. A French flyer, Pierre Le Moigne, went after the altitude mark the other day and narrowly missed death when he fell six miles out of control. He landed safely but without the record.

A Great Seaplane Harbor

SOON Montreal, Canada, is to have one of the finest seaplane harbors in the world. Two 300-foot breakwaters built out into the St. Lawrence river from points of land along the shore will inclose a body of smooth water nearly a mile long and half a mile wide—plenty of room for seaplanes to land and to take off. Arriving aviators and passengers will disembark on two floating platforms, provided in addition to mooring places for the planes.

Flood lights and air beacons will be installed for night flying. Visitors will see customs and immigration buildings, as well as restaurants and waiting rooms. The project has been approved by the Montreal Harbor Commission and the Department of National Defense.



Here is one of two huge semicircular batteries of searchlights which turn night into day for flyers landing at the new Newark, N. J., municipal airport. In all there are twenty-two of the floodlighting lamps, each of a million candlepower.

Silencing Roar of Planes

TURNING the roar of a 200-horsepower air-cooled motor into a mere hiss is the feat claimed for a new silencer developed by the makers of Fairchild planes. The invention, perfected with the aid of the Maxim Silencer Company, is a six-foot pipe as thick as a forefinger, which runs from the motor back under the cabin. It contains a metal spiral which is said to break up the sound waves without reducing power.

Other devices have recently been demonstrated to quiet airplanes without stealing power or adding to fire hazard. The U. S. Navy is experimenting with an apparatus that passes exhaust gases through the vacuum of the propeller's stream, and the changed rate of flow is expected to reduce motor noise. Soundproof cabins with walls lined with balsam wood shavings are being used experimentally in Fokker planes, and the U. S. Bureau of Standards is trying out a similar cabin under the direction of Dr. Paul Heyl, in charge of sound experiments at the Bureau. The cabins would also stop propeller noise, a sound almost as loud as the motor.

First to Fly in Antarctic

WHILE Commander Byrd and his scientific expedition were sailing toward the Antarctic, a famous explorer already there scooped away the honor of being the first man to fly a plane over the south polar region. Sir George Hubert Wilkins, who recently arrived at his base on Deception Island, Antarctica, announced that he had already piloted one of his Lockheed planes on a short flight in preparation for his projected air trip along the coast of Graham Land. He hopes to find a possible site beyond the Ross Sea ice barrier for a polar meteorological station.

Planes Wear Life Buoys

LAND planes can leave the deck of an airplane carrier for a shore visit when the sea is too rough to launch a seaplane. But should the land craft fall into the sea the plane may be lost and its crew drowned.

So the Navy recently has adopted a unique "flotation gear" to turn a land plane into a seaplane in an emergency. Two built-in compartments in the nose of the plane, and one in the rear, house barrel-shaped bags of gas-proof fabric, normally folded. But when a forced descent on water is made, the pilot pulls a lever that instantaneously inflates the three bags like balloons, from a steel bottle that contains compressed gas. With these balloonlike pontoons, a plane can float indefinitely.

A recent improvement in the device inflates the bags automatically, should the plane touch water. The entire equipment for a large bombing plane weighs only seventy pounds.

New Gun Sprays Bullets

SPRAYING bullets from a machine gun, just as water is sprayed from a lawn sprinkler, is the purpose of a unique invention under consideration by the War Department for use in fighting planes. According to the inventor, Joseph F. Butler, of Pittsburgh, it makes it unnecessary to aim a machine gun accurately; no hostile (*Continued on page 132*)

The Real Fathers *of* Flight

Wilbur and Katharine Wright flying before King Edward VII of England at Pau, France, in 1909. The King is at right of derrick. In foreground, facing the camera, is Orville Wright. Little did the Wright boys dream that injuries to Wilbur in an ice "shinny" game would lead to world triumphs.

How Two Untutored Bicycle Men Conquered the Air After Learned Experts Had Failed—The Amazing Story of Wilbur and Orville Wright, Told for the First Time in Intimate Detail

By JOHN R. McMAHON

"I HEAR the Wright boys are going camping this summer," said a citizen of Dayton, Ohio, to a neighbor in the year 1900.

"That so? Making money out of their bicycle business, I guess. Where are they going?"

"Queer place called Kitty Hawk, down in North Carolina."

"Why do you suppose they want to go that far?"

"I wonder myself. Wilbur went into a store yesterday and bought a lot of sateen cloth—twenty-five yards of it. Girl says, 'What do you want it for?' He says, 'Well, I want it.' "

"By George, I know! Those Wright boys are real original. They want to start a hunting and fishing camp — charge people money to belong—and that there cloth is to make tents and beds."

"That's it," agreed the other.

Maybe it was just as well the gossipers did not suspect that the cloth was required for wings on a flying contraption or man-carrying glider which the Wrights were to try out late that summer at Kitty Hawk.

It had taken Wilbur and Orville four years of pondering and minor experiment to create this, their first man-size model of the future airplane, and to test it for the first time in the air. They were humble beginners. They little dreamed that within three years at Kitty Hawk they would become the world's first navigators of the air and that in result of such achievement they would be received as honored guests by the rulers of five nations in Europe and the president of their own land. They little imagined that less than ten years later they would be shooing away a king, a crown prince, and millionaires galore who begged for a ride in their sky vehicle; that the King of Spain would be arguing why he should be a passenger when the Queen was not looking; that the Crown Prince of Germany would be pleading for a short trip which you and I now obtain for three to five dollars.

Wilbur, age thirteen (top), and Orville, age eight. Building their own printing press and working with tools gave them invaluable training for inventive work.

"HOW did the Wrights—uneducated —dare to attempt what they did?" I have heard dozens of people ask that question. Here were two modest bicycle mechanics, without funds and with very little schooling, essaying to compete with trained and learned men of science in the development of an epochal invention. While the Wrights were just beginning their study of flight as the merest novices, it seemed that men like Clement Ader in France, Sir Hiram Maxim in England, Octave Chanute and Professor S. P. Langley in America, were past masters in the study of aviation. They had built gliders, written learned books, made model gliders fly, and some of them were at work on ponderous power machines. They had prestige, money, and apparent science. Maxim was the famous inventor of the Maxim gun. Chanute was a leading engineer. Langley was secretary of the Smithsonian Institution, a Government museum and scientific laboratory.

And yet the unschooled bicycle men of Dayton, outdistancing all learned rivals in the world, succeeded in their quest,

and created the first airplane from which are directly derived, without basic difference or change, all the mighty fleets that roam the sky today.

How did they ever manage to do it?

For an answer, let us go back a few years, to their boyhood and youth in the simple little homestead on Hawthorn Street in Dayton, and see how the brothers qualified themselves to succeed where men of far greater technical learning and resources failed.

THE Wright family was settled in Dayton permanently in 1884. Nightly after supper the two boys, Wilbur and Orville, toiled at the dining room table with the tools of wood carving and engraving. They turned out some useless things but advanced in the knowledge of tools. The younger brother surpassed in his deftness with chisel and graver. Wilbur's ability showed in a substantial chair which he built for his ailing mother.

This boyish indoor amusement was, in effect, part of a course in draftsmanship and woodworking that became a prime advantage in the future creation of gliders and then a power flyer. Thus the boys learned to draw plans to scale—whether a wing, motor, or propeller—and how to execute them in detail. There was more wood than metal in the first air craft, and it was well they early learned the difference between ash and oak, pine and maple. This was a profitable home schooling that the Langleys and Maxims missed. A home workshop does not make everybody a great inventor, yet it develops and edges wits.

"THE Wrights are their own mechanics and won't let anybody do anything for them," was the amazed critical comment in later years amid their triumphs abroad. It was partly the reason, too, for their epochal achievement.

The former Crown Prince of Germany pleading with Orville for a ride in the air. A few years before, as Wilbur read books on flight to his sick brother, their wildest fancies did not picture themselves as being sought after and honored by princes and presidents.

Wilbur took a year's course in the Dayton high school in 1884-5 to supplement his previous schooling. Science, mathematics, and history were the subjects he studied. His academic record seems barren, but his athletic activity led to an accident without which the world would have had no airplane today.

A fellow player, in a game of shinny on the ice, accidentally struck Wilbur on the mouth with his stick, knocking out all his front upper teeth. It was a cruel injury. A surgeon bandaged the gory face.

"I'll walk home," we can hear the brave lad mumble. "Scare mother 'f I didn't." He had his way and walked.

How could this boyish misfortune promote a world discovery? Among the effects of the injury were heart and stomach trouble. There was a long period of delicate health, if not semi-invalidism. The effect in poor health kept Wilbur at home for years. He did not travel or marry, like his elder brothers.

THE age difference between himself and Orville was equalized, making possible their collaboration in inventive feats, which they continued to a triumphant end.

Orville was fourteen and in the eighth grade of public school when he formed a partnership with another boy in the printing business. The partner was Ed Sines, a crony from early childhood. The print shop, in the Sines kitchen, was equipped with a toy press, a hellbox of junk type, a few wood engravings made by Orville, and some of Mrs. Sines' embroidery stamps, all very useful in printing and decorating a catalogue.

For the Wrights, printing became a needed enlargement of mechanical talent on the road to the flying machine. It also developed into a practical source of bread-and-butter. Father Wright cheered the struggling partners with a donation of twenty-five pounds of second-hand brevier type at the same time he prompted Wilbur and Lorin to trade their jointly owned rowboat, which Wilbur had built, for a real press to be presented to Orville. This press was 3 by 5 inches, self-inking, famed as the "Model." When the partners added to this outfit some job type, they were soon emboldened to launch a school paper, styled the *Midget*.

At sixteen, Orville decided to build a printing press. He took sticks from the family woodpile and shaped them on the turning-lathe that had been earlier conjured from a similar stack of kitchen stove fuel. A junk shop supplied a metal roller which only needed a gravel filling for weight and plugging of the ends with wooden disks. After inking a form of type on its flat bed, a sheet of paper was set in place and subjected to the pressure of the gravel-loaded roller. It worked. But Wilbur cast his eye on the outfit and saw how it could be bettered.

WE CAN imagine the youthful Wilbur saying:

"This press is all right, Orv, but it would save work if you didn't have to run up and down with that big roller. Look. I'll fix a lever to shoot the roller back and forth. Then you just stand and move the lever with one hand."

The elder also helped on a tympanum device, and the pair coaxed some speed out of the woodpile press with Orv at the lever and Wilbur inking and feeding. Later they devised and built an ingenious mechanism that folded printed papers as they came from the press.

All this was typical of the collaboration between the brothers. The younger, full of eager visions, began projects which

King Alfonso of Spain, left, shown arguing with Wilbur why he should be given a ride in the Wright plane when the Queen was not looking. Wilbur showed him how the machine worked, but turned him down on flying.

The Wrights practiced teamwork even in bicycle races, Wilbur starting Orville by a push.

At sixteen, Orville built a printing press out of sticks from the family woodpile.

The Wright brothers' bicycle shop on Third Street, Dayton—a "kindergarten" where they acquired craftsmanship to build the airplane.

Left: Orville as he appeared in 1896, at the time when the brothers began studying flight.

were scrutinized and improved by the elder.

Thus, if we should tag the essential parts of the airplane with the initials of the joint creators, indicating priority of concept and improvement, the results would be:

Wing warp or flap for sidewise balance, O, W; vertical rudder for sidewise balance, O, W; horizontal rudder for fore-and-aft balance, W; wing curve, O, W; propeller curve, simultaneously W and O.

IF, AS boys, the Wrights were able to build a rather intricate machine out of nothing, we can understand how in manhood they assembled hack saw blades and other junk in a bicycle shop to create the world's pioneer device for the correct measurement of air pressure that was a prerequisite to the solution of the flight problem.

When the brothers resolved in the late winter of 1888 to publish a weekly newspaper, they wanted a sizable printing press. I imagine Mrs. Wright looked with dismay on the family woodpile, for the weather was cold. But the press was needed. It was the most ambitious of the inventors' efforts up to this time. A secondhand tombstone served as a flat bed for the press. There was a massive roller and an amplitude of wheels, pinions, pulleys, gears, and levers.

"Every part of this press ran at full speed," a member of the family told me. "It was the liveliest thing you ever saw. The racket it made was terrible."

The *West Side News*, printed on the new press, made its bow to the public in March, with Wilbur as editor and Orville filling the position of business manager.

The boys' mother died on July fourth, 1889. She left her sons a rich legacy—skill of hand and eye of her craftsman parent, original minds, the example of her own ability to create, and her sympathetic encouragement of their childish and boyish play-steps toward the making of dreams come true.

If that mother could have seen in a magic crystal of the future her sons standing in the White House, receiving gold medals at the hands of President Taft—Wilbur and Orville striding down a field with the King of Italy between them—Wilbur aflight with his sister Katharine in the presence of His Britannic Majesty Edward VII — Orville smiled upon by an emperor and cheered by 200,000 massed spectators of whom many sought to touch the hem of his garment — would she have shook her head or with a startled gasp, weeping, have believed? There is no limit to the hopeful imagination of a mother! She would have believed. And taken more joy in their useful service to the world than in the pomp and glory which attended their success.

With the eldest son married and the next permanently away, the home was reduced to three children and a father often absent on church trips. Fifteen-year-old Katharine tried to be a "little mother" to Wilbur, who was twenty-two, and Orville, who was eighteen. The trio became inseparable through the years, unbroken save by the intervention of death. No one else was as close to the inventors as this sister, their beloved "Sterchens," who was their comrade and perfect confidante.

IF THE muse of history raised a polite eyebrow because Wilbur did not graduate from high school, let her now lift the other eyebrow! Orville did not graduate when he left Dayton high school in 1889. Thus neither of the brothers even finished preparatory schooling. The Wrights never went to college.

The *West Side News* was turned into a daily in the spring of 1890 under the name of *The Item*. A funny column styled "Predictions by the Weather Prophet" was included among the tasks of Editor Wilbur. Orville's job was to make big merchants sign on the dotted line.

The Item luckily died in three months and the relieved owners turned to job printing. In the output of Wright & Wright, Job Printers, were pamphlets up to 100 pages, minutes of the United Brethren Church, and a journal for colored people. The latter was edited by Paul Lawrence Dunbar, a young negro who had been Orville's classmate in high school.

DUNBAR was given to original poems which he recited in the print shop. One day he scribbled on the wall an effort that is doubtless omitted from the collection which brought fame to the Afro-American poet. But it has an interesting touch of appreciation, if not prophecy:

Orville Wright is out of sight
In the printing business.
No other mind is half so bright
As his'n is.

The Wrights were as pleased with Dunbar's later success with his Pegasus of poetry as he was over their feat with a mechanical steed of the air. The brothers were strong in loyalty to early and old friends.

The job printers branched out in 1892 with the addition of a bicycle repair shop to their line. No doubt they were lured into this by the idea of playing with a new machine, the ball bearing "safety" with compressed air within rubber tires. "Wright Cycle Co." was the legend put above the modest shop on Third Street. That sign remained blandly unchanged through the years, long after the proprietors had advanced their activities from the creation of ground to aerial vehicles. It is interesting to consider that the bicycle trade was a kindergarten to many who later found fame and fortune in automobiles and aircraft. For the Wrights it was a real stepping stone toward the

(*Continued on page 152*)

After success had come—the inventors' father (center), with Orville at his right and Katharine, seated with friends on the lawn of their new home at Dayton. John R. McMahon, the author, can be seen beside Orville.

Tides Make the Earth Boil Over

By EDWIN W. TEALE

© S. Machara. Courtesy Dr. T. A. Jaggar

With this terrific explosion not long ago, Mt. Kilauea in Hawaii, normally tranquil, went on rampage. As volcanos age, eruptions are less frequent and more violent.

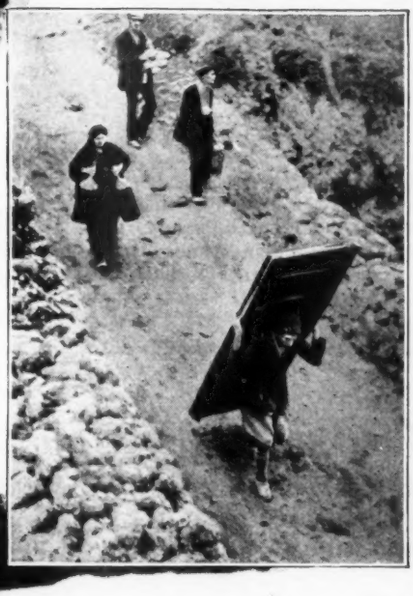
RECENTLY the world read that thousands of refugees, carrying pitiful bundles of salvaged goods, were clogging the roads of eastern Sicily, fleeing from an eruption of Mt. Etna. For five years this 10,758-foot volcano, fringed with villages and vineyards at its base, had been quiet. Then Vulcan's forge flared anew.

From an opening in the side of the mountain—which, strangely enough, remained covered with snow at its top!—there crept a devastating dragon of fiery lava sixty feet high. Dividing into three streams, it advanced down the mountainside, devouring trees and buildings in its incandescent flood, and pushed ahead for fifteen miles toward the Ionian Sea. When, after twelve days, it had run its course, a town and two villages had disappeared, 7,000 people were homeless, and 10,000 fertile acres had turned to ridges of stone. Etna had again proved its right to the crimson dot that marks it on the map!

If you look over a detailed map of the world you will find three or four hundred of these red dots, each marking a volcano of comparatively recent activity.

Not all active volcanos erupt, as did Mt. Etna, like a boiled-over pot. Many explode, shooting dust and ashes miles into the air. The nonexplosive character of Etna is ascribed by volcanologists to the fact that its lava is a relatively thin liquid which allows steam and gas bubbles to escape readily. In explosive volcanos, the lava is thick. It holds back steam and gas stubbornly, causing immense pressure beneath, and eventually a violent eruption.

Left: Mt. Etna's latest eruption. Below: Refugees fleeing down the side of the mountain.



A FEW years ago, scientists discovered the strange fact that lava is hotter *at the surface* of a crater than in its interior! Dr. Arthur L. Day, director of the geophysical laboratory of the Carnegie Institution, Washington, D.C., descended to the very floor of the fire pit of Kilauea, in Hawaii, wearing a gas mask as protection against the poisonous fumes. With flames shooting all about him, and the heat charring the soles of his heavy shoes, he took measurements which revealed that twenty feet below the surface of the lava the temperature was 100 degrees C. lower than on the surface. One explanation is that one third of the gas from the crater is hydrogen, which burns at the surface, increasing heat.

A seething caldron of molten lava. This spectacular night photograph shows a vent in Kilauea after a violent explosion. The interior is white hot and hung with glowing stalactites. Scientists, braving death to measure heat in Kilauea's fire pit, have found the lava hotter at the surface than in crater's interior.

As volcanos grow old, their eruptions become less frequent and more violent. Etna is comparatively young, possibly not older than 100,000 years. The most destructive of the fiery mountains are tranquil for long periods. Bondaison, in Japan, was quiet for 1,000 years before its outbreak in 1888. Vesuvius, most famous volcano in the world, was described as being verdure-clad before it belched death upon Pompeii. The most terrible of all known volcanic disasters occurred on the Island of Martinique, in 1902, after Mount Pelee had slumbered for fifty years. A single puff of its fiery breath snuffed out 30,000 lives in the city of St. Pierre. A single human being remained alive through the disaster—a negro prisoner locked in an underground dungeon.

At one time it was believed that all volcanic lava came from a central reservoir, formed by the molten heart of our globe. Now, however, the earth's interior is believed to be more rigid than strongest steel. Instead of being of deep-seated origin, volcanos are now thought of as a "skin disease" of the earth. Lava is believed to originate at moderate depths, which Charles F. Talman, of the U. S. Weather Bureau, says probably never exceeds half a dozen miles. Some volcanologists hold that lava is carried by rootlike channels running around the earth; others that small individual pockets or reservoirs of molten rock are formed beneath each crater.

(*Continued on page 151*)

Planes Bomb "Warship" on the Desert

Life-Size Dreadnaught, Painted on Sand, Blown to Bits by Shower of Missiles from the Air in Amazing War Game

California National Guardsmen painting the outline of the U. S. S. *California* on the glaring white sand of the Mohave Desert, as a target for air bombers.

Attaching bombs to releasing mechanism under lower wings of the bombing plane.

WITH whining steel propellers, five California National Guard airplanes recently wheeled into position over the shimmering Mohave Desert and released a series of high-explosive bombs in a new type of practice maneuver. On the bed of a dry lake below, the exact outline of the U. S. S. *California*, painted to scale, had been shaped by guardsmen, using black crude oil for paint, and brooms for brushes. Even the turrets and big guns of the naval giant stood out, exactly reproduced in size by the black oil upon the white, alkali-covered desert floor.

Toward this strange battleship of sand the speedy war planes discharged their bombs—thirty-two in all. As each struck, it detonated with a roar, raising a huge cloud of smoke and dust. Three of these death-dealing bombs struck at almost the same time, all landing within the lines marking the deck of the dreadnaught. When the flock of war birds headed back for the home field, the outline of the ship had been blown to pieces and its position was marked by a series of holes torn by the exploding bombs.

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Now You Can Eat Sunshine!

Here Is the Story of a Man Who Gave Away His $1,000,000 Discovery to Make Folks Healthy—How the Sun Is Being Put to Work

By
FRANK PARKER STOCKBRIDGE

Prof. Harry Steenbock, of the University of Wisconsin, who discovered that food bathed in sunlight will aid in preventing disease, and presented mankind with amazing new health cereals.

By eating "sunburned" food, everyone, by proxy at least, can now bask in the sun's rays that our distant ancestors once worshiped and that our modern physicians have found vital to health.

WITHIN the last few weeks a new breakfast food has appeared on the shelves of grocery stores throughout the country. During its making, it has been bathed in artificial sunshine from high-powered electric lamps. It is the first of new "irradiated" health foods that you may soon expect to see upon your grocer's shelves. And it is the first result of a sensational process that might have been worth a million dollars or more to a University of Wisconsin professor, had he not preferred to give it away.

When Prof. Harry Steenbock, the originator of the process, made his astounding discovery that sunlight-bathed food will prevent rickets, dread bone disease, and will probably help to check tuberculosis and anemia, he feared that his knowledge might fall into the hands of unscrupulous profiteers. So he snapped off the powerful sunlight lamps in his laboratory, put back in their cages the white rats that had led him to the epoch-making find, and applied for a patent. When he obtained it, he presented the food-making process, patents and all, to the University of Wisconsin.

Great manufacturers of food products heard of the discovery, came to Steenbock, and were referred to the University's trustees. There they learned that they would be licensed to use the sunning process, provided they did not increase the price of their product because of it. Several important firms accepted the opportunity, one of them now paying the University $50,000 a year for its license. Now the first of the new products, an irradiated cereal, is being produced commercially. Others are to follow soon.

In a Chicago hospital, crippled children suffering from bone tuberculosis are treated with artificial sunlight from ultra-violet lamps. Here one of the small patients is having his sun bath.

SOME day science will find out definitely what influence the light of the sun—particularly the ultra-violet rays, which Dr. Steenbock and others produce artificially with their so called "sunlight lamps"—has upon human life, and how and why. The Incas of Old Peru, the ancient Zoroastrians and their successors, the Parsees of today, and many other religious cults, have held that all life comes from the sun, and modern research seems to be proving that they were right. We have long used the expression "a healthy tan," in referring to the darkening of the skin by exposure to sunlight. The knowledge that this burning of the skin is done by invisible ultra-violet rays is very recent; still newer is the discovery that these ultra-violet rays carry into the body life-giving properties to which the name of vitamins has been given; newer yet is the knowledge that unless we take these vitamins into our bodies with our food, as well as getting them into our systems through our skins, we cannot live healthily nor very long.

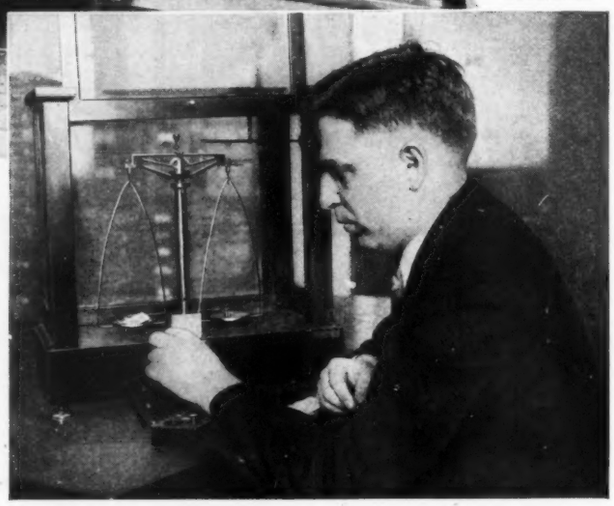
Women are beating the male sex to it in the application of this aspect of science

Making artificial suns. Here is a view in a factory where ultra-violet lamps are being manufactured to supply sunlight treatment.

to life, Dr. Ephraim R. Mulford, president of the New Jersey Medical Society, told a convention of doctors the other day. Already they are healthier and longer-lived than men, more resistant to disease and more resilient under strain. Dr. Mulford attributes this to the modern fashion among women of wearing fewer and scantier clothing. They expose themselves to the life-giving ultra-violet rays, whereas men persist in covering their bodies from neck to ankle with thick, dark clothing. The whiter and more porous the material of our clothing, the more easily do the ultra-violet rays of the sun penetrate to the skin, the United States Bureau of Standards reports. Dyed fabrics, and even those slightly yellowed by age, shut them off almost completely. The one-piece bathing suit or the still scantier costume of the Oriental dancer would seem to be more in line with what Nature intended us to wear!

WE DIG our graves with our teeth by rejecting the vitamin-bearing foods in favor of sugar and starches, says Dr. Seale Harris, of Birmingham, Ala., in a report to the American Medical Association. Lowered resistance to infections of all kinds, in the nose and throat as well as in the stomach and intestines, results from a diet consisting mainly of white flour bread, white potatoes, white rice, lean meats, sugar-saturated coffee, sugar-laden desserts, sweetened soft drinks, and candy, says Dr. Harris, comparing the increased prevalence of abdominal disease with the increase in sugar consumption.

Fifty years ago the average person ate twenty-six pounds of sugar a year; now he eats 106 pounds. Frequent colds, pneumonia, tuberculosis, appendicitis, stomach ulcers and gall-bladder disease are attributed to lack of vitamins in the diet of the average sedentary American. Catch your own food and eat it raw and you will get all the vitamins you need. The human machine functions best when we eat only what we can capture, pluck



An expert of the U. S. Bureau of Standards tests the proper weight of cotton and rayon cloth to admit the health-giving ultra-violet rays.

or dig barehanded, combining muscular effort and exposure of our bodies to the sun with a diet which is rich in vitamins because it, too, has been exposed to the sun.

Since that mode of life is impractical in our industrial civilization the best practical compromise is probably to eat a much higher proportion of fats, nuts, raw fruit, and green vegetables, wear the lightest clothes we can tolerate, walk in the sunlight as much as we can, and trust to luck.

WHILE Prof. Steenbock was feeding cereal to white rats in his darkened mid-Western laboratory, other experimenters here and abroad were bottling sunshine for human needs. From laboratories in England and Germany came the news that a substance had been discovered which, exposed to sunshine, or ultra-violet light, became a remedy thousands of times as potent as cod liver oil. Six ounces of it equal a ton of the fish oil, it is said. Known as ergosterol, this substance, formed from yeast and activated by sunlight, is present in small quantities in every healthy person. But let it be lacking, and a dose so small that it could hardly be measured would remedy the trouble. So powerful is this substance that an overdose of a few grains might prove deadlier than arsenic.

How this magic substance was found is in itself an absorbing story, that started with efforts of scientists to make cod liver oil more pleasant to take. The first attempts to make the oil palatable, by purifying it, destroyed its curative value. That gave the first clue; perhaps the beneficial ingredient was actually an impurity. Prof. George Barger, of the University of Edinburgh, pursued this clue and found the answer—the whole medicinal value of the oil was confined to ergosterol, which is found as an impurity in fats.

WHEN Dr. Adolf Windaus, a German expert of the University of Goettingen, proved that by exposing ergosterol to sunshine or to ultra-violet lamps he could obtain a substance with all the curative power of cod liver oil and digestible by the most sensitive stomach. For that discovery he has been awarded the Nobel Prize in chemistry for 1928, a cash award of more than $40,000.

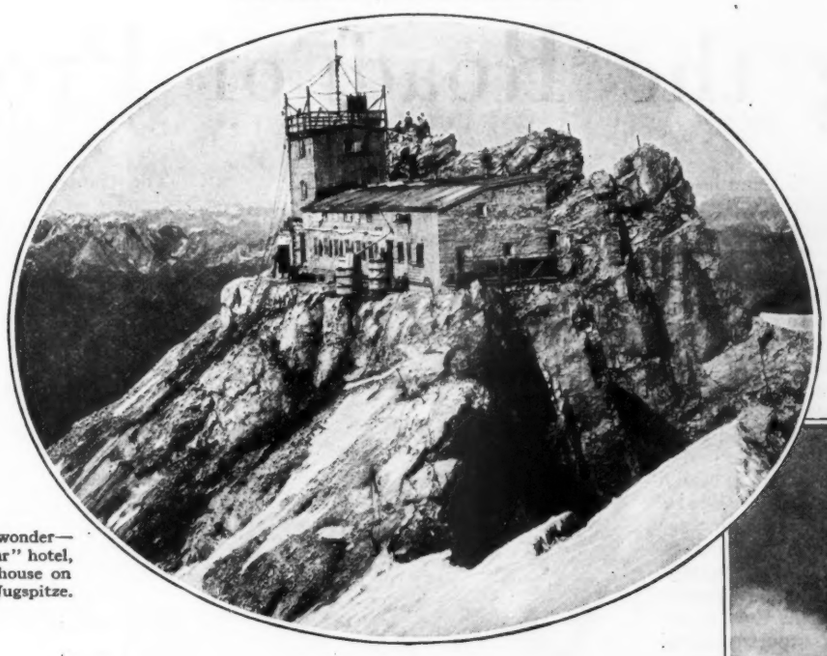
In other words, cod liver oil owes its beneficent effect wholly to an impurity—which, in turn, owes its power to sunlight that filters through the water to the swimming fish.

When sunlight hits ergosterol, it turns it into "vitamin D"—one of those mysterious, necessary components of foods which scientists now believe owe their health-giving potency to the fact that they absorb and retain sunshine. Vitamin D, which is the rickets-preventing vitamin, is manufactured in the human body by an interesting process which scientists are just now beginning to understand. Ergosterol, already contained in the body, finds its way to the surface of the skin, where it is bathed in sunlight. Then it is reabsorbed with its health-giving vitamins. It is because it aids in this process that cautious bathing in the artificial sunshine of suitable electric lamps is now recommended by medical men, who also believe that people whose bodily "sun-bottling" apparatus is defective can make up the deficiency in an indirect way by eating food that has been treated with sunshine.

TO DEMONSTRATE that sun baths can be taken in food, Professor Steenbock raised two broods of white rats.

One brood he deprived of a part of their normal diet, and they developed the bone disease of rickets. The other brood he sun-bathed daily in the artificial light of mercury lamps. At length he killed the rats of the second brood and fed an extract of their livers to the undernourished ones. The ricket-afflicted rats became healthy again.

Thus he proved that treatment with ultra-violet rays could be given indirectly, in food. Next he exposed quantities of flour and farina, rolled oats and other cereals, to the powerful rays of mercury lamps and fed them to ricket-afflicted rats. These rats, too, recovered. Then Professor Steenbock announced his discovery of how to put healthful sun- (*Continued on page 158*)



A new engineering wonder—the tiny "sleeping car" hotel, perched like a bird house on the pinnacle of Jugspitze.

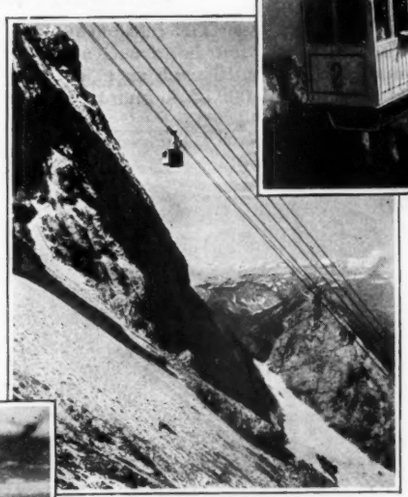
Going up! This little car, hanging on an aerial cableway nearly two miles long, carries guests to the hotel.

Sky Railway Runs to Strange Hotel

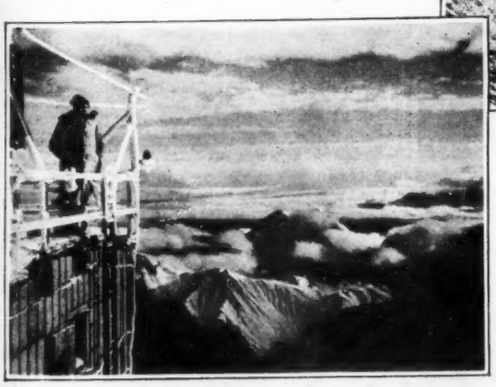
TWO great engineering feats were combined recently in a single enterprise that may be numbered among the wonders of the world. One is the famous hanging-car aerial cableway that climbs to the top of Germany's highest mountain peak, the Zugspitze, more than two miles above sea level. The other is the construction of the world's loftiest all-year hotel, perched on a sharp crag that forms the very pinnacle of the mountain. The second was made possible by the first.

The hotel, a Lilliputian hostelry smaller than a regulation-sized sleeping car, probably involved more problems of construction than the largest hotel ever built. It was designed like a sleeping car, not to be fantastic, but because of the meager space available, and also because of the difficult and dangerous task of lifting materials to its lofty perch.

A thrilling ride if you don't get dizzy. At right is the hanging car, with load of passengers, near the mountain top.



Almost like the sheer wall of a skyscraper is the rugged mountain-side.



Standing on the balcony, high above the clouds, visitors at the tiny mountain-top hotel are thrilled by the marvelous bird's-eye view of mountain tops and valleys below.

A landing place near the summit, used by the hanging-car cableway, gave rise to the audacious idea of providing a modern-equipped mountain-top hotel. The cableway, first of its kind, extends from a station in Austria, 2,800 feet above sea level, up 11,000 feet to the mountain's summit.

The tiny "sleeping car" took six months in building. The first task was to break up 2,500 cubic yards of rock to make a suitable foothold for the hotel. Wood construction was used because of the drastic change in temperature, which caused enormous expansion and shrinkage of material, and because cement froze before it could be used.

Storms, snow, and ice greatly hampered the work. The peak was swept by a seventy-mile gale and in winter the thermometer dropped to zero and below. The crews of eighty men had to be changed from week to week, so gruelling was the task. Three men were lost; one fell into a chasm and two were caught in snow slides.

All building materials, machinery for an electric power plant, furnishings, heavy porcelain plumbing and pipes, furniture and equipment for a restaurant capable of serving 250 hungry guests at a single meal, pumps for a reservoir, a large steam heating plant, food and fuel for the workmen, and finally the workmen themselves, had to be hauled up the rugged mountain sides or carried in the tiny cable cars that hold only twelve people and take twenty minutes for each trip!

There are berths for seventy-three in the "sleeping car." First-class bedrooms are "outside," with windows looking upon the magnificent view below.

The total cost of the Zugspitze cableway and the hotel was about $1,000,000.

Along the Road of Progress

EVERY shade and tint can be reduced to a numerical formula, expressed in figures, by means of a device known as the recording spectrophotometer, recently invented by Professor Arthur C. Hardy, of the Massachusetts Institute of Technology. The apparatus automatically analyzes the light rays reflected from any object of any color and records in ink, on a chart, the precise proportion of each of the primary colors, red, yellow and blue, which combine to make the shade under observation. The chart reading is easily reduced to figures, so that it is possible to describe any color or tint in numerals which will enable anyone having access to one of Professor Hardy's instruments to match it perfectly without a sample.

The practical uses of this device are innumerable. A fashion expert visiting Paris for an American dress manufacturer, for example, can cable the mathematical formula of the newest fashionable shades so that they can be reproduced precisely without delay. To the man whose wife asks him to go to the store and match a piece of silk or a pair of stockings it should prove an inestimable boon. No longer will he have to try to discover what the shopkeeper means by such vague terms as "ecru," "mauve," "elephants breath" or "moonlight," actual names given to colors!

Farms in the Sahara?

RECLAMATION of the Sahara Desert, long discussed, is now receiving attention as a serious project by the French government. Dwight Braman, of Boston, Mass., an irrigation engineer, has worked out the plan for letting in the Mediterranean through canals and damming the rivers which flow down from the Atlas Mountains. This would create a great inland sea covering 30,000 square miles. The moisture from evaporation would change the climate for hundreds of miles in all directions, possibly affecting that of southern Europe as well. The soil is rich and, with water available, would be highly productive.

This project, if carried out, might change the whole course of international trade and put North Africa back on the map as a center of civilization.

New Material for Airship Bags

THE U. S. Bureau of Standards announces that its technicians have developed a substitute for goldbeaters' skin for use in the manufacture of the gas cells which, inflated with hydrogen or helium, lift an airship.

Goldbeaters' skin is an expensive product. It is prepared from the intestinal membrane of the ox, and derives its name from its use in the final process of manufacturing gold leaf. Sheets of gold are reduced by previous beating to such thinness that 950 of them, piled alternately with squares of the skin, measure only three quarters of an inch in thickness. This pile, or "mold," is then beaten for four hours with a seven-pound hammer until each sheet of gold leaf is only 1/150,000 of an inch thick.

Necklace 35,000 Years Old

Henry Field, Assistant Curator of Physical Anthropology, Field Museum, Chicago, is seen here examining a necklace believed to be 35,000 years old, found in a cave in southwestern France. It contains 250 beads carved, it is thought, from the tusks of mammoths.

The thinness, toughness, and imperviousness of the goldbeaters' skin has made it heretofore the only substance light and tight enough for airship gas cells. Each skin measures five inches square, and it took 500,000 of them to make the gas cells for the dirigible *Los Angeles*.

Commenting on that fact, an Irish newspaper recently gravely informed its readers that the little animal known as the goldbeater, a native of North America, which derives its name from its habit of beating or stamping upon the ground in the vicinity of the gold mines of the Far West, was in danger of extinction, so many were being killed for their skins to make airships!

Will the Ocean Overflow?

TO MOST of us Commander Byrd's expedition to the Antarctic savors more of adventure than of science; but if his researches on the south polar ice cap answer but one question they may prove of the greatest value to the world.

That question is: Is the Antarctic ice cap melting?

If it is, then the seacoast cities of the world might better begin now to move inland, to high ground, for the complete melting of the Antarctic ice would release enough water, now stored as ice, to raise the level of the whole ocean by fifty feet, according to Sir Edgeworth David, of Sydney, Australia, a distinguished explorer and geologist.

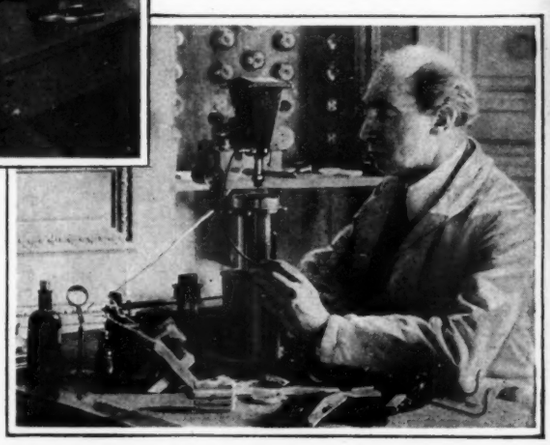
There seems to be ground for belief that the tradition of a world-wide flood, persistent among all ancient peoples, may have originated in the rise of the oceans when the Arctic ice cap melted at the end of the last Ice Age, approximately twenty thousand years ago.

New Cancer Hope

CANCER is a disease for which no definite cure has been found except the use of the knife in its early stages. One woman in eight and one man in fourteen dies of cancer. It occurs most frequently in people whose blood is alkaline. Dr. Charles Mayo, famous surgeon of Rochester,

New Machine to Fight Cancer

The newest aid in the study and treatment of cancer is this electrical machine, perfected by Charles Weyl, of the University of Pennsylvania. It measures the acid-alkaline balance of the blood in terms of voltage.



Detects Artificial Pearls

By photographing the heart of a pearl, the instrument at the right, invented by M. Reisler, a French chemist, determines whether it is genuine. A small camera is focused on the gem through a powerful lens.

Brief Bits of Fact and Interesting Comment from the Month's Records of Discovery and Invention

Minn., recently told the American Public Health Association that the tendency to cancer is hereditary. Cuban authorities are considering a proposal to permit scientists to experiment on condemned criminals with cancer inoculations, instead of putting them to death.

A treatment, less repugnant, may result from the use of a machine recently developed by Dr. Charles Weyl, of the University of Pennsylvania. This machine diagnoses the disease and directs its treatment by measuring the relative amounts of alkali and acid in the blood.

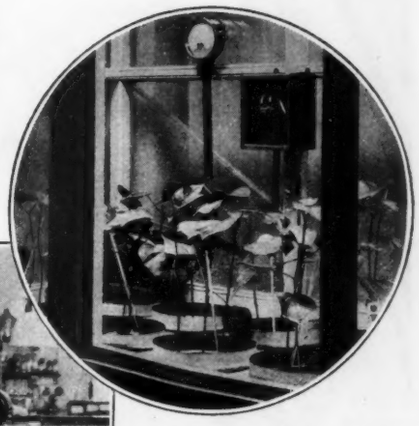
An Artificial Heart!

LIFE remains one of the unexplained phenomena of the universe. It seems improbable that scientists ever will be able to produce life from nonliving materials, but through an amazing series of laboratory experiments many things about life and death are being learned.

Recently the Moscow Scientific Institute reported that the head of a dog had been kept alive for three hours after it had been severed from the body. And in a glass jar at the Rockefeller Institute of Medical Research in New York there is part of a chicken's heart which the famous Dr. Alexis Carrel has kept alive for nearly twenty years.

The Moscow experiment, conducted by S. J. Brukjanenko and Dr. S. I. Chech, after the animal had been placed under an anesthetic, was accomplished by means of an artificial heart made of steel and rubber which pumped blood to the dog's head. The experimenters declared that the detached head swallowed food, although there was no stomach for it to go into, snarled and bared its teeth, and responded to the slightest touch. Tests made with quinine and cheese indicated that it was capable of tasting.

In a similar experiment in Russia, a monkey which apparently had been dead for hours was resuscitated by the injection of its own blood, and at last report was alive and normal. Just what the future may bring from these experiments it is impossible to tell, but from such research physicians learned how to resuscitate patients, after the heart had stopped, by the injection of adrenalin.



The Tropics in a Box

Above is the world's strangest tropical cotton plantation—a glass box only a yard square, where plants grow under blazing electric "sunlight" turned on and off by clockwork. It is used in the Rothampsted Agricultural Experiment Station, England, to study a disease of African cotton fields. Left: Examining soil bacteria employed by planters to increase their crop yield.

No Fire in Redheads?

A SCIENTIFIC pronouncement which may start lively arguments comes from a report of the British Social Hygiene Council. This indicates a belief that redheads, instead of being natural fighters and fiery adventurers, are really victims of an inborn inferiority complex.

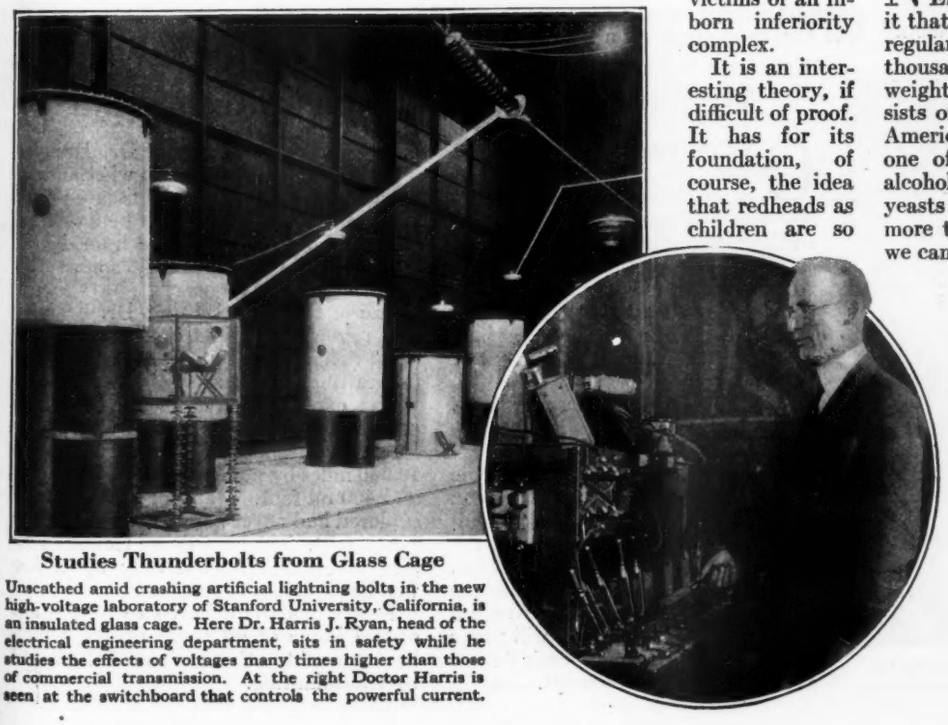
It is an interesting theory, if difficult of proof. It has for its foundation, of course, the idea that redheads as children are so teased that they are forced into being vigorously on the offensive-defensive, until it becomes a habit. Schoolroom jests often have a lasting effect on the lives of people. It is related of Napoleon that he first determined to be a soldier when a schoolmate twitted him about his small stature, saying that there wasn't enough of him to make a soldier.

Every Man His Own Still

NATURE has slight regard for the Eighteenth Amendment, but sees to it that every human being has his or her regular daily supply of alcohol. Three thousandths of one percent of the total weight of the normal human body consists of alcohol, says the Journal of the American Medical Association. Each one of us is constantly manufacturing alcohol from the sugars, starches, and yeasts we eat as food, but it would take more than a hundred times as much as we can get in this way to produce intoxication.

To discover what goes on in the chemical laboratory of the human body is a quest upon which scientists are working more than on any other single problem. The mechanics of the body, considered as a machine, have long been well understood; its chemistry still holds fascinating mysteries. It may take a long time to uncover all of them, but we have plenty of time ahead of us. A billion years, at least, is the latest estimate of the future duration of the earth, according to Prof. R. A. Millikan, of the California

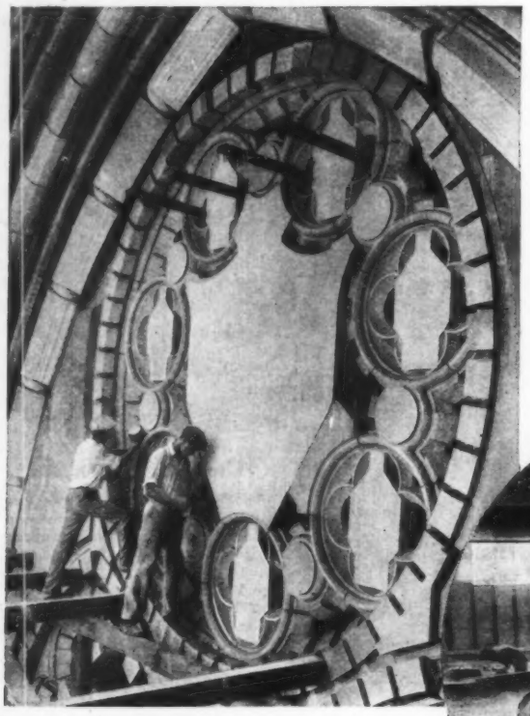
(*Continued on page 150*)

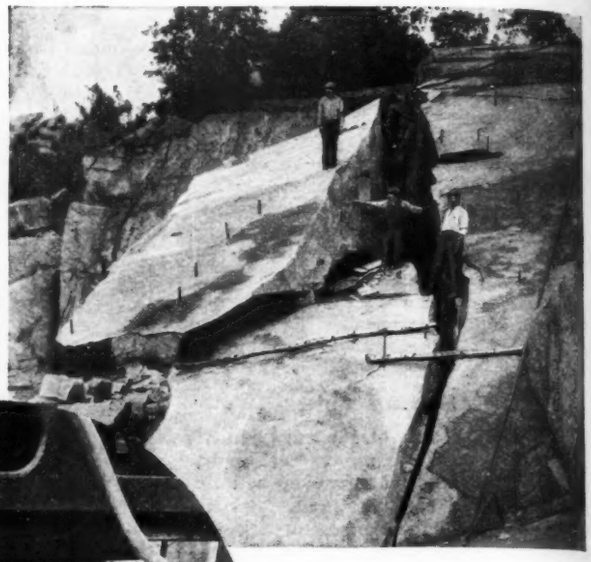


Studies Thunderbolts from Glass Cage

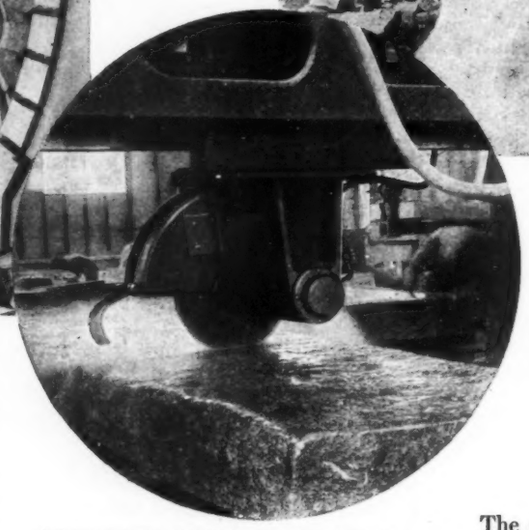
Unscathed amid crashing artificial lightning bolts in the new high-voltage laboratory of Stanford University, California, is an insulated glass cage. Here Dr. Harris J. Ryan, head of the electrical engineering department, sits in safety while he studies the effects of voltages many times higher than those of commercial transmission. At the right Doctor Harris is seen at the switchboard that controls the powerful current.

Cathedral Blasted from Cliffs





Turning the rocks into a mighty edifice of lasting beauty. Right: A great block of granite blasted from the quarry. Left: Stone cutters fashioning a design above one of the cathedral doorways.



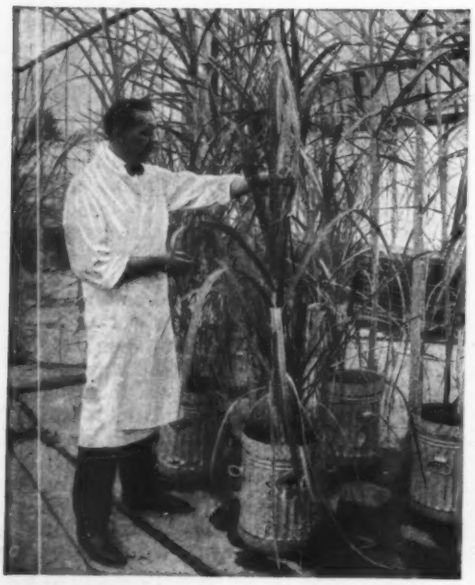
A huge granite slab being cut by giant carborundum wheel, cooled by a stream of water.

NEAR Peekskill, N. Y., the old Mohegan granite quarry, unworked for years, has been reopened to supply stone for the building of the great Cathedral of St. John the Divine, on Morningside Heights, New York City. Amid the skyscrapers of the metropolis, the cathedral will be unique in that it will contain no steel or wood. It is being constructed entirely of stone, to last for centuries. The granite extracted from the quarry is of a light brown color and is reputed to hold its color in spite of weathering and the onslaughts of time.

The huge masses of rock are blasted out in solid chunks, cut in pieces, and finally fitted into place at the cathedral. The cutting is done by a carborundum disk, spinning at high speed and pressed down into the hard stone by a weight above. During the operation water is poured over the disk and stone to keep them cool, as illustrated at the left.

When the slabs have been cut to the desired shapes, they are transported by motor truck to the site of construction. Each piece is marked carefully to indicate the exact position it will occupy in the building. All that is necessary is for the workmen to fit the pieces together and cement them in place.

The granite edifice, which is expected to last at least twenty centuries after it is completed, will be the third largest cathedral in the world. St. Peter's at Rome and the cathedral of Seville, Spain, will be the only ones surpassing it in size. It is estimated that at least ten years will elapse before the structure is completed.



Dr. E. W. Brandes, sugar plant specialist of the Department of Agriculture, with one of the new varieties.

Airplane Explorers Find a New Sugar

ONE of these days you may be sweetening your cereal, or your coffee, with an entirely new brand of sugar—scouted for by airplane, found by a searching party crashing through the brush of New Guinea wilds, and brought back to this country with 166 other varieties by Dr. E. W. Brandes, sugar plant specialist of the U. S. Department of Agriculture.

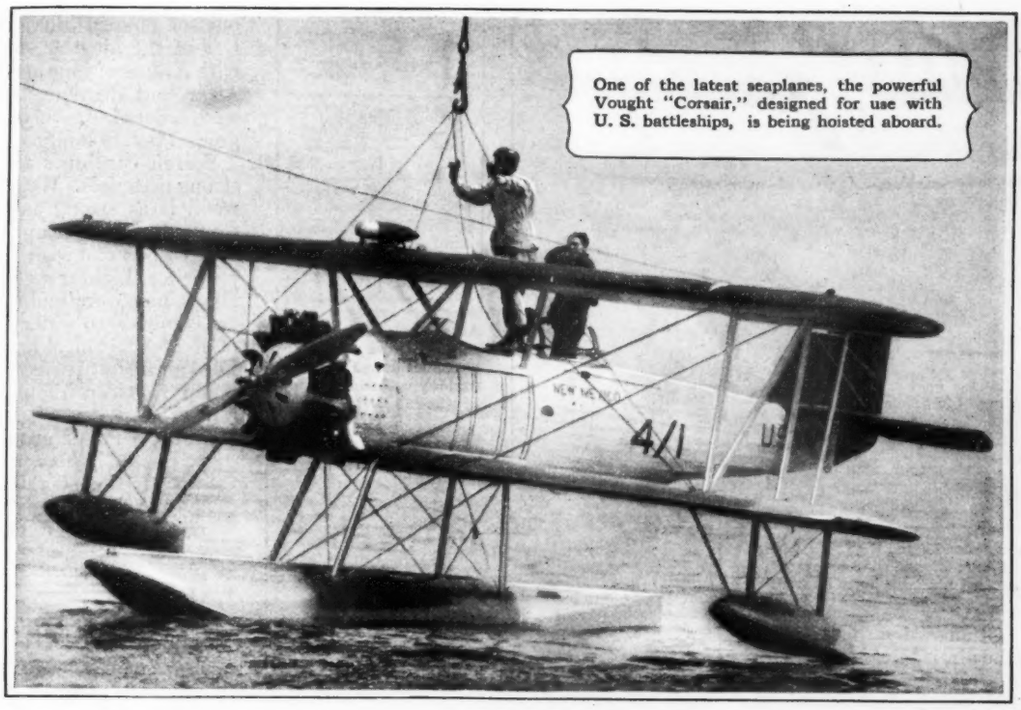
Cuttings of the new sugar plants, with which Dr. Brandes has just returned from an eight-months' expedition to this tropical Pacific island north of Australia, have been planted in the Government agricultural station at Rosslyn, Va. At the end of a year new cuttings from these plants will be taken to the cane fields of the Southern States to see if one of the many varieties will prove resistant to the curious mosaic disease that menaces native crops.

It will be several years, Dr. Brandes says, before it will be known whether any one of his new varieties is disease-proof, but there is good reason to believe that some one of them, or some hybrid produced from it, may revolutionize the sugar industry.

One of the varieties that Dr. Brandes found grew to a height of thirty feet. It is not rich in sugar but might prove useful for grafting purposes.

The expedition was the first ever to prospect for new plant life by airplane. In all, Dr. Brandes and his party traveled 10,000 miles by plane, 700 miles by canoe, and 400 on foot. Many of the places he explored had never before been visited by white men. They are dense tropical jungles, and are inhabited only by a few wandering tribes of natives.

New Guinea is believed to be the ancestral home of all sugar plants, which have spread to other regions of the world by transplanting.



One of the latest seaplanes, the powerful Vought "Corsair," designed for use with U. S. battleships, is being hoisted aboard.

New Marvels of Plane Design

Astonishing Secrets of Engineering Behind the Latest Triumphs of Speed, Power, and Reliability in Aircraft

By ROBERT T. POUND

IN CALIFORNIA, recently, a 2,000-pound plane took the air with a cargo weighing more than two and a half times as much as the plane itself! It was the greatest load ever carried by a heavier-than-air machine.

In this absorbing article, inside facts and secrets of engineering that have made possible the marvelous speed, strength, and lightness of modern flying machines are revealed by a veteran Army airman.

THE other day a Curtiss Army plane, equipped with a Wright Whirlwind motor, sped over Langley Field, Va., at 137 miles an hour. That was a pretty good clip for this type of machine, though not unusual.

The unusual part of it was that the tachometer on the pilot's dashboard showed the propeller turning over at the rate of only 1,900 revolutions a minute. To an Army pilot, that is almost miraculous, because at this propeller speed the best such a plane ordinarily will do is 118 miles an hour.

Where did the extra speed come from? Over the nose of the machine, hiding most of the engine, was mounted a curious cowling that resembled a bottom-up bowl with the base knocked out. The hole allowed the propeller shaft to poke through.

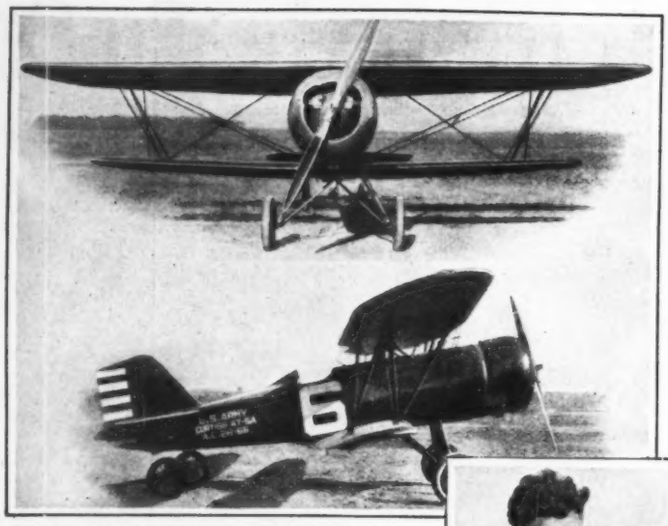
Known as a "Venturi cowling," this device, just developed by the National Advisory Committee for Aeronautics, slashes the normal drag on a plane of the air whistling past an air-cooled engine. By making the air stream pass in a smooth stream around the fuselage, it adds more than thirty percent to the effective horsepower of an air-cooled plane in flight.

How new plane models are tested. Recording instruments give experts in New York University aeronautical laboratory results of wind tunnel test.

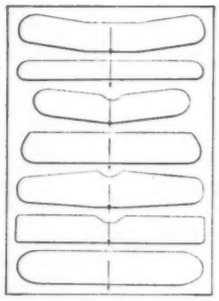
Military experts hail the invention as the most valuable single contribution to airplane efficiency since the war. It is an example of efforts to improve the whole design of airplanes—efforts beset with difficulties of which the average man never dreams.

Imagine designing an airplane light enough to carry a heavy "pay load" in addition to its own weight—strong enough for safety—frail enough for a featherweight motor to drag through the air—and well-shaped enough to offer the least possible resistance to forward motion. Add to that, too, the fact that it must be easy to control and economical to run. The wonder is not that we fly across oceans, but that we can fly at all.

Strength and lightness—the two are inseparably bound together, as every airplane maker knows. It's easy, for instance, to make a wing brace that is strong. It's easy to make one that is light. But when you try to combine the two, what you have is a piano-wire brace so delicate that it must be scrapped if bent, in shipping, by so much as forty-five degrees from a



Curtiss AT-5 Army plane fitted with new Venturi cowling which, by reducing wind resistance, increases plane's speed nineteen miles an hour

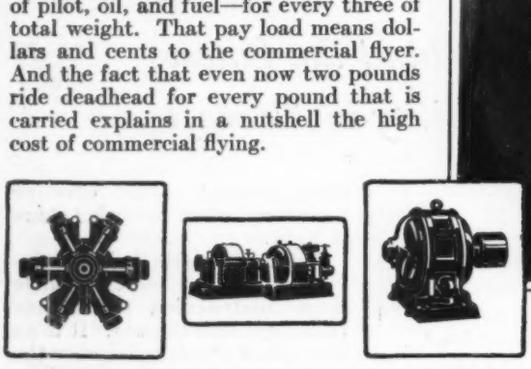


An example of the diversity of modern airplane construction. Here are some typical wing shapes of the 1929 airplanes.

straight line. Otherwise a pilot, some bumpy day in the air, is likely to be in for a rough time.

Every hundred pounds of added weight, in a plane, means three more horsepower to pull it. It has taken years to bring commercial planes to the point where they can carry one pound of pay load—that is, lifting power besides the weight of pilot, oil, and fuel—for every three of total weight. That pay load means dollars and cents to the commercial flyer. And the fact that even now two pounds ride deadhead for every pound that is carried explains in a nutshell the high cost of commercial flying.

Scale model of world's largest flying boat, by E. F. Burton, California aircraft designer.



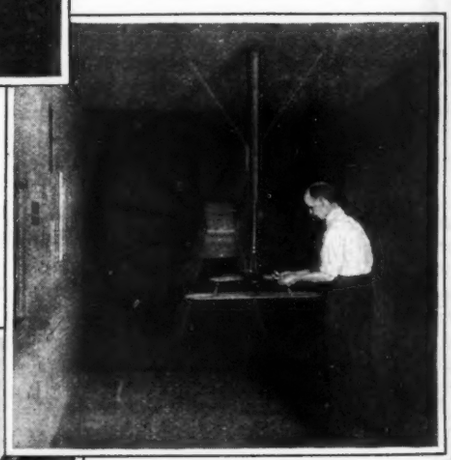
Why planes use gasoline power plants. The best gasoline motors (left) weigh only a pound and a half to the horsepower; steam turbines (center) six to eight pounds; electrically-driven motors (right) seven and a half pounds.

Only within the last year or two have new instruments been designed in making the weight-versus-strength compromise. They eliminate guesswork as to what particular parts of a plane need to be strongest. By photographing the rise of liquids in small tubes, or the movement of beams of light from the sun or lamps on photographic paper, these instruments record pressures and strains in various parts of a plane in flight. By such measurements it was discovered not along ago that loads on a certain wing part were twice what manufacturers had been allowing for. Small changes in tail structure suggested by them have improved certain planes difficult to control at critical speeds. They also cured a certain plane's habit of going into a flat spin.

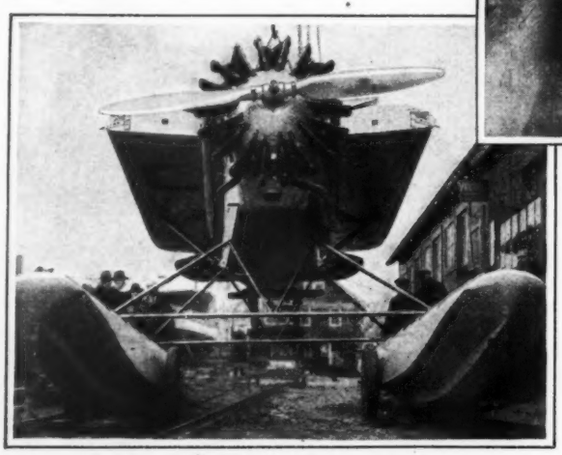
During the war the writer wondered why he had to wind so many rubber shock absorbers to replace broken ones on machines used to train cadets. Thepressure-detecting instruments explained it. A one-ton plane, stalling six feet above the earth, hit the shock-absorbers with a blow of four and a half tons! After that discovery student pilots were ordered to level off a foot above ground before landing.

Search continues for lighter but strong materials. Weight for weight, wood is as strong as the strongest steel. Birch is cheaper to use than metal when one wishes only a single propeller. Lighter metals, aluminum alloys like duralumin for instance, are coming into wider use as a result of greater technical knowledge. The Ford air liners are covered with duralumin fourteen thousandths of an inch thick.

Many parts of an airplane could be made lighter than they are now, if the machine were to be flown only by capable men. The material, though, would snap like matchsticks under careless handling. And the designer, knowing that some clodhopper may clamber over fragile parts, adds a pound for safety and thereby drags more power from an already burdened engine. In ordinary engineering terms, a "factor of safety" means that a structure is strong enough to sustain a certain number of times, say six times, its maximum load. In a plane, a factor of safety of six means that it will stand six times its *normal* load, a very different thing. In spite of this necessarily close margin—for under certains conditions such as a steep dive a plane may practically wipe out its factor of safety—structural parts almost never break in flight except through stunting or careless handling.



Testing a forty-inch scale model of a transocean seaplane in wind tunnel, to determine air-worthiness of design.



A striking departure from the usual airplane designs—the Fairchild amphibian monoplane, with wings that fold back when the plane is to be stored in its hangar. This was the first ship to reach the stranded *Bremen* at Greenly Island.

If the load can be scattered along the wings instead of all concentrated in the body, then the structure can be made lighter. One designer moves two motors out on the wings. Ten other designers follow. Then another thinks of splitting the body in halves lengthwise, with a motor in front of each half. Still another offers a plan that calls for practically no (*Continued on page 134*)

When the Sky Rains Soldiers!

THE next war, if any, may be fought with parachutes! Battalions of armed soldiers dropped from the air may play a decisive part in tomorrow's combats.

Several recent developments presage this astounding innovation. From three planes speeding over Brooks Field, San Antonio, Texas, a machine gun and its crew of three men were dropped to earth, where they set up their weapon and got it into action in three minutes. Meanwhile a British invention, a detachable parachute-cabin for troop-carrying airplanes, holds promise of landing troops a squad at a time from the air. And in the United States successful trials have been made of parachutes designed to bring a whole airplane safely to earth.

Over enemy lines, a fleet of transport planes might fly. At a given signal, the bottoms would literally drop out of the planes and bullet-proof cabins, like great packing boxes, would rain from the sky to discharge load after load of infantry, and bring confusion in enemy ranks.

Merely by pulling a lever, the pilot could launch one of the cabins. A small pilot parachute shot from the plane by compressed air would release a larger or intermediate parachute. This in turn would exert enough force to drag into the air a mammoth parachute that would lift the entire cabin loose and lower it to the earth, where shock-absorbers would break its fall. Then the plane would fly back to its base for another cabin.

A possible battle scene of the future, based on recent inventions. Bullet-proof cabins filled with shock troops, machine guns and gunners, even airplanes themselves, may be dropped from the sky upon enemy territory by myriad parachutes.

Painted especially for POPULAR SCIENCE MONTHLY *by B. G. Seielstad*

Swimming Turtle Is "Hour Hand" of Novel Clock

A TURTLE tells you the time in a unique timepiece produced in Switzerland. At first glance, the clock appears to be a sundial with a circular tray, filled with water, set in the face. In this tray a small imitation turtle floats, carrying a piece of steel in its beak. As the hour hand advances under the tray it attracts the turtle by means of magnets.

If removed from the water and later replaced, the little turtle immediately swims across to the point on the tray directly above the hand, thus indicating the time.

The eight-day-clock mechanism is wound in the usual way, and regulated after the tray and the face of the timepiece are removed.

According to the importers, who recently brought the novel timekeeper to America, the beautiful marble base in which the clock is set makes the instrument suitable for display upon a pedestal or table center, serving as an ornament as well as a dependable timepiece.

Floating in the tray, the little turtle moves around the dial like the hour hand of a clock.

How Much Do You Know About Astronomy?

HERE are ten questions selected from hundreds asked by our readers. See how many of them you can answer. Correct answers are on page 166. You'll find this an entertaining way to test your knowledge in one of the most fascinating fields of science.

1. What are the shooting stars?
2. Of what substances are the sun and the stars composed?
3. How do astronomers know the distance to the moon, the sun, and the stars?
4. What is a comet?
5. Are the moon, the planets, or the stars inhabited?
6. Why does the eclipse of the sun by the moon completely blot out the sun only in a narrow path?
7. What is the ring around Saturn?
8. What is beyond the stars?
9. Why can't we see the stars in the daytime?
10. Why do stars twinkle?

Air Propeller Drives Passenger Catamaran

WITH its twin hulls sinking only nine inches into the water, a unique air-driven catamaran carried nine passengers and attained a speed of nine miles an hour with full load when put through its paces recently at Dudley, England, by its inventor, W. F. Davies.

The two skull-like hulls are driven forward by an airplane "pusher" propeller spun at the rear of the boat by a four-cylinder, water-cooled motor. The operator, steering the vessel with a wheel, sits behind the passengers in the streamlined body, near the motor. Doors, similar to those in an automobile, enable the passengers to enter and leave the body of the boat easily. Strips fastened to the top of the hulls prevent accidents to passengers through slipping.

Rocky Mountain Wilds Are Reserved for Science

SEVERAL million acres, comprising forty-two separate tracts in the Rocky Mountain Forest District, have been set aside by the U. S. Department of Agriculture as "wilderness areas" to be used for science and recreation.

Thirteen small areas in the national forests of Colorado, Wyoming, and South Dakota have been set aside for scientific observation and research, and all commercial and recreational activity in that territory is prohibited. A 100,000-acre wild, inaccessible area on the Washakie National Forest in Wyoming is closed to commercial use and open for recreation. The remaining twenty-eight areas, including 2,451,020 acres in Colorado, Wyoming, South Dakota, and Minnesota, will be kept in a wild state.

"Busy Bee" a Myth—He's a Loafer, Tests Show

DR. LLOYD R. WATSON, of Cornell University, a scientist who apparently doesn't care what happens to our pet illusions, has just announced the results of fifteen years of research work among the bees, which showed him that these insects, accepted as symbols of industry, are really work-shirkers.

The professor, who has been making bees "punch a time clock," has discovered that, instead of toiling from morning till night, as generally believed, they make from six to ten trips in quest of honey and loaf the remainder of the day. Meanwhile, he has tried to develop a really busy breed of bees, and as a result of these experiments the number of varieties which have actually profitable characteristics has been reduced to four.

Human Body's Electricity Reported Photographed

IN RESEARCH work tending to show that the human nervous system is an intricate electrical network with the brain as its semiautomatic switchboard, two scientists in Munich, Germany, claim to have photographed electric current issuing from a man's body.

The current waves are said to have been amplified to a point at which pictures could be taken. The photos, it is reported, showed sparks radiating from the fingers of an outstretched hand.

If the skin is dry, the experimenters declare, even the slightest motion of the fingers will produce sparks that can be "snapped." The pictures further showed that the oscillations increase when the fist is closed and opened quickly.

Weak Feet Walk on Air in New Arch Support

"WALKING on air" is more than a figure of speech for users of a new arch support which is pumped up with a small hand pump. The air cushion, attached to a thin inner sole, is made of a rubber composition said to possess great strength.

One of the supports is reported to have withstood a pressure equivalent to the weight of twelve heavy men. The chief advantage claimed for the invention over the ordinary metal support is increased comfort and "springiness" in walking.

Inserting pneumatic arch supporter, attached to inner sole. The air cushion is pumped up.

Opals, Once Feared, Today Yield Vast Fortunes

ALTHOUGH a popular superstition persists to the effect that opals are harbingers of death and sorrow, Australia, the chief source of the world's supply of these gems, derives revenue estimated at millions of dollars from them. An opal valued at $5,000 was found recently near Walgett, New South Wales.

Australia, too, enjoys the distinction of being the only country to produce the much-admired black opal. One specimen of this stone, weighing six and a half carats, was found in 1910 and sold for $550. In 1920, another specimen brought $3,000. The black opals are the product of Wallangulla Field, New South Wales.

Since 1890, the total value of opals won in Australia has been estimated at $7,750,000, and this figure does not include the prices realized for some very fine pieces found and sold privately. In various parts of New South Wales some 12,000 acres of opal-bearing country remain unprospected.

Enjoying general favor among the Greeks and Romans of antiquity, the opal fell into disrepute in the Middle Ages, when it was believed responsible for the Black Plague, of which people died by the millions. It is from that time that the superstition regarding the opal as a bringer of unhappiness dates.

Queen Victoria, determined to popularize the gem product of her colonies, overcame much of the prejudice by presenting opals as wedding gifts to each of her daughters.

Steam-Puffing Granddaddy of Modern Auto Found

DUST-COVERED and with the paint peeled from its ancient body, what is thought to be one of the earliest ancestors of the 23,000,000 motor vehicles now in the United States was uncovered recently in an unused portion of a laboratory at the University of Maryland.

This early "horseless carriage," using steam as a source of power, is said to be the invention of the late Dr. William E. A. Aiken. Dr. Aiken was professor of chemistry at the university from 1838 to 1888. His machine—with the smokestack placed conveniently at the rear—was built long before the automobile era was ushered into America on April 19, 1892, by the success of the gasoline automobile invented and piloted by C. A. Duryea.

The queer steam "horseless carriage," unearthed, after nearly half a century, from a university laboratory in Maryland

Latest Ice Cream Cone Wears a Bonnet

ICE cream cones that wear caps, invented by C. K. Gummerson, of Pittsburgh, Pa., are said to keep the ice cream in shape from five to ten minutes longer than in ordinary cones and to protect it from dirt and street dust.

The cap also may be used separately as an ice cream container. A flat baked cake wafer is supplied as a lid to protect the contents of this small ice cream "plate." The cap, which is made of the same material as the cone, can also be eaten.

Life Span 100 Years by 1950? Experts Differ

CENTENARIANS may be the rule instead of the exception in 1950, according to Arthur D. Rees, formerly of the University of Pennsylvania faculty, who sees no reason why a 100-year average life span should not be the usual thing. Increased knowledge of disease and dietetics will shortly extend old age far beyond the Biblical "three score and ten," he believes.

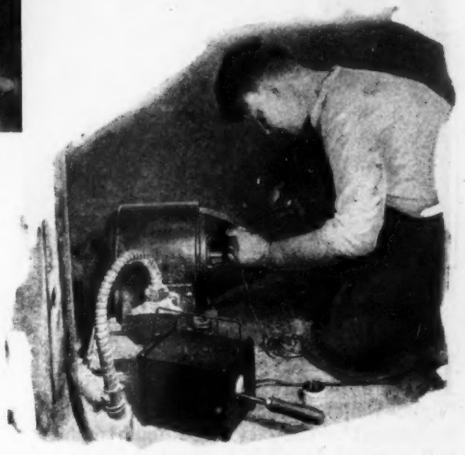
A life of 100 years without a day of sickness is prophesied by Dr. George Walker, of the Johns Hopkins medical faculty. Long life, he says, is not a matter of luck, but of correct eating.

Less optimistic is Dr. Louis I. Dublin, statistician of the Metropolitan Life Insurance Co., who states that we have made little advance in lengthening life in the last eighty years. More people are living to old age, he says, but this is because we are saving more lives at younger ages, not that we have lengthened life. And Dr. Alfred E. Cohn, biologist of the Medical Research Department of the Rockefeller Institute, asserts that old age is a natural process, and medicine only has made it more comfortable.

Soldering Jobs Simplified by Electric Furnace

ONLY eight inches long and six inches wide, a portable electric furnace has been devised for heating soldering irons for small jobs. The temperature of the heating chamber is said to rise quickly to more than 900 degrees F., but an automatic control prevents it from mounting high enough to burn the point of the soldering copper. As further protection, the temperature where the soldering point rests is kept lower than at the center.

The furnace is designed to operate with any 110-volt electric light or power circuit and to consume current at a rate not greater than that of three 150-watt lamps. The device weighs ten pounds and is carried by means of a handle.



Portable electric furnace, in foreground, heats the irons for a small soldering job on a motor.

Know Your Car

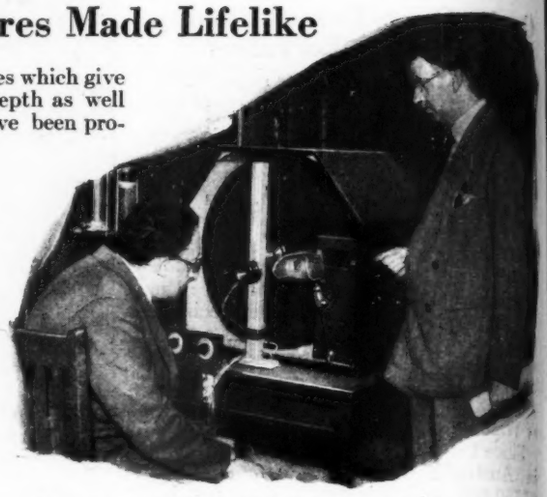
HARD starting is a winter motoring trouble that is avoidable. Cold weather affects the functioning of the car's mechanism in several ways, and all of these are cumulative in causing hard starting.

Much more current is consumed by the starter motor to start a very cold engine, due to the friction of the congealed oil. The short period of daylight causes you to use the lights more than in summer. In addition, you probably do not take any long rides in cold weather. The result is that more current is drawn from the storage battery than is put back by the charging generator. Consequently the voltage is low and the spark correspondingly weak just at the time when a hot spark is most needed to ignite the chilled and only partly vaporized mixture.

An extra charge for twelve hours at a time with a full rate radio battery charger will help to eliminate hard starting. Once every two weeks is sufficient.

Radio Pictures Made Lifelike

TELEVISION pictures which give the impression of depth as well as width are said to have been produced by John L. Baird, pioneer Scotch television experimenter, by using a stereoscopic receiving set. Behind the spinning disk, with its spiral perforations, two pictures appear simultaneously. When seen through two prismatic lenses, the two images seem to combine and give the impression of a solid object.



Apparatus for receiving television pictures in stereoscopic relief being demonstrated by its inventor (standing at right).

In the United States, an official designation for the area of a single picture in television was announced recently by the Radio Manufacturers' Association. The word "frame" will be used, as in moving pictures. Each frame is to be scanned in forty-eight lines. The scanning will proceed from top to bottom and from left to right. Fifteen separate frames or complete picture area scannings a second will be the standard speed of showing. This decision was reached in an effort to standardize television equipment.

Searchlights on Wheels Aid Fire Fighters

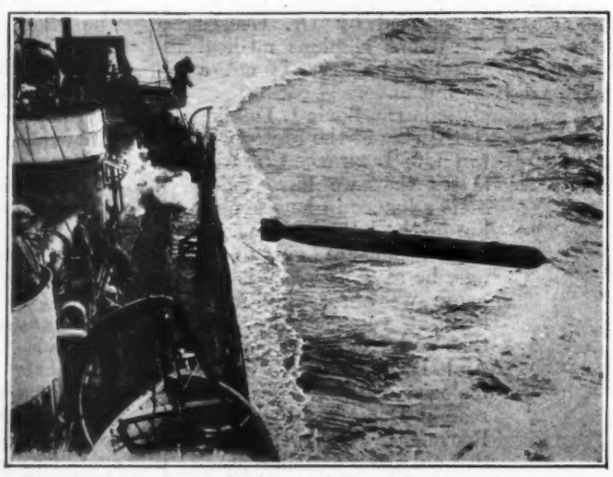
FLOODLIGHTING has become a part of fire fighting in Chicago. A new "light wagon," recently added to the equipment of the city's fire department, will respond to all important calls, furnishing light by which the firemen can work more effectively. Mounted on the top of the truck are a number of large searchlights which can be directed at any angle upon a burning building. Within the truck a large gasoline motor runs the dynamo which generates the electricity used in the lighting, making the apparatus an independent unit in itself.

It is believed that this arrangement, by which "all fires will be fought in the daytime," will prevent accidents caused by men stepping into holes in the dark or stumbling over unseen objects. It will also enable fire officials to judge more accurately when burning walls and timber will fall, giving them time to protect their men from such danger.

Cameraman Snaps Torpedo Diving into Waves

LIKE a succession of huge flying fish skimming over the water and dropping into the waves, a series of torpedoes sped from the deck of one of the latest destroyers during recent tests in the English Channel. A photographer aboard the warship snapped one of the giant missiles as it plunged through the air, obtaining the remarkable photograph that is reproduced below.

The vessel is one of several destroyers constructed by a British shipbuilding concern for the navy of Chile. The rapid-fire discharge of practice torpedoes formed one of the concluding tests through which the war vessel was put before its acceptance by the Chilean government.



Remarkable photograph showing giant torpedo an instant after it was shot from the deck of a new destroyer built for the Chilean Navy.

English Hard for Parrots

PARROTS, tested at the municipal zoo in Dallas, Texas, demonstrated that they could learn Spanish easier than either English or German. One parrot speaks Spanish words picked up from countless Mexican visitors and has never spoken a word in English. In El Paso a parrot learned Spanish and Chinese, but seldom spoke English.

Gypsum Increases Soil's Capacity for Moisture

MAKING land thirsty is the work of a new apparatus developed by the U. S. Department of Agriculture. In the western states some irrigated fields, known as hard spots, or hard land, do not absorb water readily. Experiments have shown that irrigation water containing more sodium than calcium increases the hardness of such soil. In other words, "soft water makes hard land and hard water makes soft land." Gypsum, dissolved in the irrigation ditches, increased the ability of such spots to absorb water. So experts of the Department devised an automatic apparatus for adding gypsum to irrigation water.

Tribesmen Jail Idols If Prayers Are Unanswered

WHEN their prayers are not granted, Moroccan tribesmen bind their religious images with ropes and leave these fetters on until the desired happening occurs or their displeasure abates, according to Edward A. Westermarck, noted English sociologist, who has just concluded a study of their ceremonies.

A similar instance is reported to have occurred in China in 1888. The mandarins of Canton prayed to a god to stop an incessant downpour of rain. When he turned a deaf ear to their pleas, they put the idol in jail. When the rain ceased, they returned it to the temple.

Masks Safeguard Health of Paint Spray Users

AT LEAST nine tenths of the lead in air containing paint mist is removed by the use of respirators with cotton, paper, or fabric filters, Surgeon General H. S. Cummings announces as the result of experiments by the Public Health Service, in Washington, D.C. The addition of a canister of activated charcoal eliminates most of the solvent vapors as well. These canisters of charcoal may last for weeks, the report states, before the contents become saturated and useless. The experiments were carried on under conditions considered extreme, high percentages of paint being in the air.

A bird's-eye view of the gigantic new highway across the James River. It cost $7,000,000.

Begin Search for Diamond Fields in Canada

ARE there diamond fields in Canada? Not long ago, some diamonds of commercial size were found in Indiana by tourists who examined debris around the rock mounds left in parts of that state at the end of ancient glacier drifts. Discovery of this treasure has revived interest among scientists in the possibility that there may be diamond-bearing rock in the James Bay region in Canada.

The Indiana diamonds are by no means the first to be found in the United States. Diamonds have been encountered in Georgia, Kentucky, Virginia, Tennessee, Wisconsin, California, and Oregon. A crystal weighing twenty-three and three-fourths carats was found in Virginia in 1855, and one weighing twenty-one and one fourth carats in Wisconsin in 1886. A number of small diamonds were unearthed near Murfreesboro, Pike County, Arkansas, in 1906.

News of the recent Indiana find has resulted in exploration in Northern Ontario, but although some small crystals found there have been pronounced diamonds by Dominion mineralogists, their identification has not thoroughly convinced diamond experts. Even if the stones are diamonds, they are said to be so small as to possess little commercial value.

Big Trees, Centuries Old, Found to Be Fireproof

ONE of the reasons for the amazingly long life of the California Big Tree, the forest giant which reaches an age of 4,000 and sometimes even 6,000 years, was discovered a few weeks ago. Experiments with its bark showed that it has a resistance to fire surpassed only by that of asbestos! Consequently, the great tree survives the forest conflagrations which destroy its more inflammable brethren.

A piece of the bark twelve inches square was put in a wood fire in a lumber mill furnace and burned for eight hours. At the end of the test, the bark was no more than charred on the outside.

Five-Mile Highway Built Across James River

THE world's longest highway bridge, a five-and-a-half-mile span crossing the James River in Virginia, and connecting Newport News, Norfolk, and Portsmouth, was opened to traffic recently.

Built at a cost of $7,000,000, the new bridge closes a large gap in the Atlantic Coastal highway and forms a direct road down the historic Virginia Peninsula.

The huge span rests on piles which, in many cases, descend 100 feet under the surface of the water. In one spot, the bridge rises to a height of 200 feet above the river, but most of the twenty-three-foot roadway is fifty feet above the water level. The great structure has one of the largest lift-spans in existence, three hundred feet long with a lift of fifty feet, allowing space for even the largest vessels to pass through.

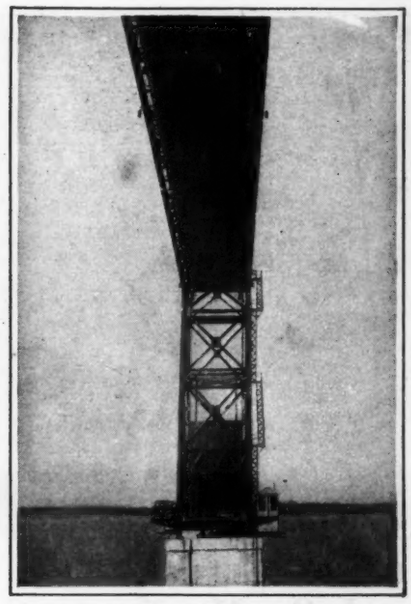
The James River Bridge is the only one downstream from Richmond, which is seventy-three miles from Newport News. Together with the two older bridges across Chuckatuck Creek and the Nansemond River, it completes a long-needed link between the Virginia Peninsula and the mainland.

Compressed Air Drill New Aid to Surgeons

THE pneumatic drill, familiar to engineering, is the newest of aids to surgeons in the operating room. Dr. W. H. Ogilvie, an assistant surgeon at Guy's Hospital, London, England, is the inventor of the new surgical instrument, pictured below. It is designed for use in difficult bone operations and is constructed on the same principle as the compressed-air drills used in steel construction.

The miniature drill is connected with a cylinder of compressed air, which is carried in a holder that rolls on casters. Thus it can be transported readily from room to room. The drill is controlled by a trigger on the "gun grip" handle by which the surgeon holds it.

Pneumatic drill for surgeons' use in bone operations. It is driven from the compressed air cylinder at left.



The huge lift span, 300 feet long, raised to a height of 200 feet above the river surface.

Your Busy Heart Is Fed by Tiny "Dinner Pails"

THE adult heart—the only organ in the body whose muscles never rest nor sleep during life—makes an average total of 108,000 beats every twenty-four hours! How does this busy organ find time to "eat" and fortify itself for its arduous labors?

It remained for a Japanese scientist, Professor Y. Kato, of the Okayama Medical College, to solve this interesting mystery. Kato, after a long period of investigation, announced the other day that he had discovered that Nature has provided what may be described as little "dinner pails" from which the muscle fibers of the heart—which, indeed, has scarcely time to "eat"—are ingeniously "fed."

He studied small fragments of heart muscle under the microscope and found tiny disk-shaped organs between the muscle fibers. He injected chemical reagents into the blood of animals and, after examining their heart muscles, observed that these substances had accumulated in the little disks.

On these and other facts the Japanese scientist bases his theory that the disks are, in effect, dinner pails, which collect food materials from the blood and pass them around to the heart muscles.

Plan World's Largest Airplane Plant

THE largest aircraft manufacturing plant in the world is soon to be built in California, according to a recent announcement by interests that have purchased control of the Fokker Aircraft Corporation. Anthony H. G. Fokker, creator of the ships that bear his name, remains in charge of design.

Airplanes of all types will be produced in enormous quantities. Already the Fokker plants here and abroad have manufactured 16,000 planes.

At left: The "solitaire" tennis device installed on a roof of a building. If the ball is missed it is not lost, for it is fastened to a rope stretched between the two poles by a rubber band, which snaps it back to the player when hit.

Rubber Band Returns Ball In One-Man Tennis

YOU can play tennis with yourself by means of a simple, one-man tennis outfit, recently introduced into this country. Smashing lobs and speedy backhand strokes can be practiced in your own back yard without fear of smashing windows or losing balls, the makers of the device point out.

A long rubber band with a tennis ball attached to the end is fastened to the center of a thin fiber rope stretched between two tall poles. The ball is put in service in the usual way, and the rubber band speedily returns it each time it is struck. Skill is required to drive the ball at the correct angle to make it return directly to the player at the right height for another drive. Amateur and professional players who have used the device say that it gives valuable training in controlling the direction of strokes and also in timing them properly.

How the apparatus may be set up on the roof of an office building or hotel is illustrated by the photograph above, in which Wallace Bates, a former tennis champion, and a friend are shown trying out the new device.

Below: This open-air ice skating rink, using the new chemical ice substitute, can be used in summer or winter.

Chemical Makes Open-Air Ice Skating July Sport

ICE skating in a bathing suit under a broiling summer sun has been made possible by the recent discovery, in Germany, of a chemical substitute for ice. When sprinkled over a smooth floor, the chemical immediately hardens into a solid polished surface over which the sharp runners of the skates glide without cutting through. This artificial ice will stand high temperatures and can be used in outdoor rinks even in the middle of July. Its expense is negligible compared to the upkeep of a skating rink using real ice.

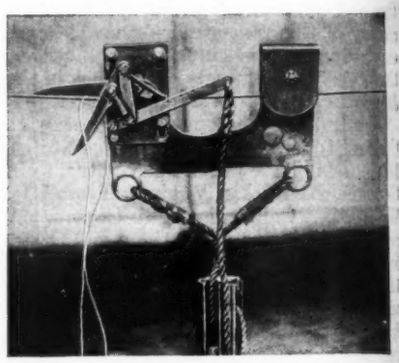
A miniature model of the Potsdamer-Platz, Berlin, with tiny automobiles and street cars, is used to teach German policemen methods of controlling the traffic at this and other congested points.

Air Landmarks Should Be Yellow, White, Black

CHROME yellow, white, and dead black are the three best colors for markings to guide aviators, such as towers of transmission lines along an airway and field boundary markers, according to Woody Hockaday, Aeronautics Division, U. S. Department of Commerce. When these three tints are used in combination to paint stripes upon the landmarks, it is explained, the white and yellow reflect the light and the dead black provides a contrasting background to give high visibility. Beacon sites on Federal airways are fifty-six-foot chrome yellow arrows made of concrete.

Traveling Shears Clear Phone Lines of Litter

CLEARING telephone and telegraph wires of kites and other entanglements has been made easier by the invention of Albert Hightower, a Fresno, Calif., lineman. The mechanism consists of a trolley truck carrying a pair of strong shears operated by a rope and so designed that it cannot jump the wire once it is properly mounted. The shears will cut through rope and cloth and will even sever small limbs of trees which sometimes fall across the lines.



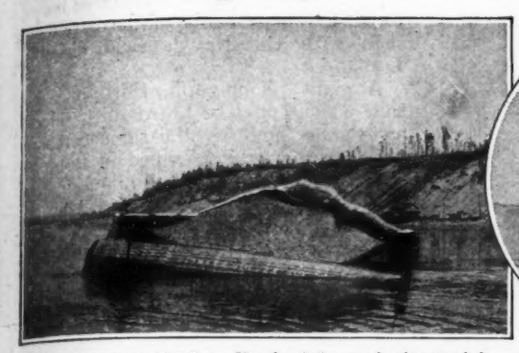
Shears, slid along the telephone wires on a trolley, cut away rope and other entanglements.

Traffic Problems Revealed by Working Models

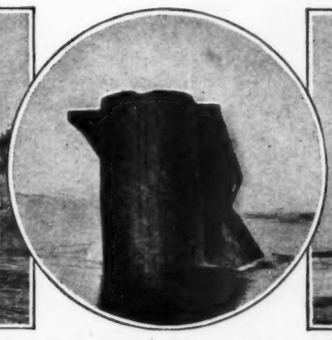
TOYS are now being used to teach traffic cops of Berlin, Germany, to do their work more efficiently. Tiny horses and wagons, automobiles, and street cars move along the streets of a miniature model town, part of which is shown in the photograph at the left, while the policemen, under the direction of an expert traffic officer, determine how the little control station at the street intersection should be operated to control the traffic meeting from five separate streets.

Miniature wooden policemen, with their arms indicating "stop" or "go," are placed near the control tower to help give directions. A map on the wall behind the table gives a bird's-eye view of the thoroughfares of Berlin. Realistic touches are added to the street corner scene in the model—which, by the way, represents the famous Potsdamer-Platz—by the addition of little trees, lamp-posts, and pedestrians.

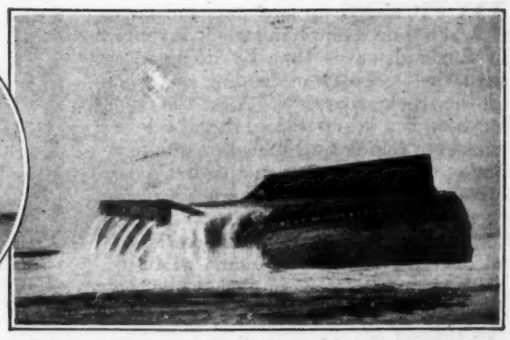
Self-Dumping Scow Turns Somersault in the Water



The start of the flip-flop. The loaded scow begins to sink on one side, as the underwater flood tank fills with water.



Over she goes! The emptied scow in the somersault.



The scow bottom side up. The water ballast is seen pouring from the flood tank, and the deck is ready for a new load.

A SELF-DUMPING scow that flops over on its back and receives its next load upside-down, is being operated in the Puget Sound by a Seattle, Wash., company. Both the top and the bottom of the scow are identical, so it can be loaded whichever surface is on top. The unusual boat is 100 feet long, thirty-six feet wide, and eleven and one half feet deep. Braced "sideboards," four feet high, keep the load in place while it is being towed.

The scow, built of wood, is divided lengthwise internally into two halves, each half containing an air-tight compartment and a flood tank operated through two eight-inch valves. On one side the air-tight compartment is placed above the flood tank, and on the other, below it. A trip rope from the towing tug opens the flood valves on the side in which the flood tank is below the air-tight compartment. As this tank fills with water, the greatly increased weight on that side throws the load out of balance and causes the scow to turn completely over. The air-tight compartment, now being on the bottom, raises the flood tank above the water line so that the water drains out as the scow is towed back to its loading berth.

A 500-cubic-yard load can be carried by the boat and dumped in this manner.

Grafts Part of Human Eye in Amazing Operation

WHEN, in 1908, Dr. Hugh Mackay Dawbarn, the famous American surgeon, saved his son's life by grafting a large piece of his own skin onto that of the boy's, the operation astonished surgeons and physicians as well as laymen throughout the world.

Since then, many wonderful grafting operations have been performed, but it was left for a surgeon in the New York Eye and Ear Hospital to transplant, for the first time, part of one man's eye to the eye of another, saving the sight of the latter. The results of this amazing operation, performed a few weeks ago, were reported satisfactory.

The sufferer in question, an inmate of the Home for the Blind, has one glass eye. The other eye was obscured by a cataract to a point where hardly any vision was left him. This eye was restored by grafting upon it the cornea—the transparent part of the coat of the eyeball—from the eye of a patient to whom it had been rendered useless by growth of a tumor.

The delicate operation had to be performed in record time to prevent the living tissue of the cornea from dying before it was transplanted to the eye of its new owner. When the bandages were removed, the patient's patched eye was found to have a vision of about ten feet.

Catch Birds in Fish Nets

PROBABLY the stupidest winged creature is the auk, a small, web-footed, penguinlike bird whose haunts are the Arctic regions. A Canadian zoölogist, recently returned from the Far North, described the catching of droves of auks by Eskimos who were armed only with fish nets! The birds apparently cannot distinguish men from rocks.

The scientist estimated that he saw more than 100,000 auks on Hakluyt Island alone. Their behavior, he said, is that of little soldiers on parade. They advance in long straight lines.

Invents New Front-Wheel Drive for Autos

ANOTHER attempt to apply the power of an automobile motor to the front wheels instead of the rear has been made recently by a French automobile engineer, M. Sensaud. In the picture above, the casing of the main driving gear may be seen in the center of the complicated front axle, just below the radiator of the automobile. Power is applied to the wheels through a system of gears.

The close proximity of the driving wheels to the motor is expected to give greater efficiency by reducing loss of power in transmission. Front drive cars frequently have been built and a number have attained prominence on the race tracks, but they never have reached great popularity with the ordinary motorist because of the difficulty in steering them.

Where Half of the World's Gold Is Weighed

IN A stream of yellow ingots, more than half the gold produced in the world passes through the weighing rooms of a refinery at Germiston, near Johannesburg, South Africa. Unrefined blocks of gold representing a fortune are piled before the weighing official, who places them in the pans of sensitive scales, operating within dust-proof glass cases. The weight of each is recorded before native laborers carry them to the refining plant.

The latest figures available, those for 1926, reveal that the South African mines of the Transvaal produced more than $200,000,000 worth of the precious mineral during that year. The total production for the world was valued at less than $400,000,000. Of this amount, the mincs of the United States yielded slightly more than $46,000,000.

Weighing blocks of gold, each worth a small forture, on delicate scales in the refinery near Johannesburg, Africa.

New Hand Truck Picks Up Piles of Boxes

BY PICKING up two stacks of boxes at a time, a new hand truck, invented in England, saves time by doing away with the necessity of loading each box on the truck separately. After the truck has been run into position, the wheels are held from rolling by application of a foot-brake. A hand lever then operates a pair of clamps at the front of the truck, causing them to grip the boxes at the bottom of the piles. The body of the truck, slightly wider than the two columns of boxes, holds the upper boxes in place while they are being wheeled. At the destination, the clamps are released and the boxes discharged in a neat pile.

A pair of mechanical arms, operated by lever, grasp the bottom of the double pile of boxes.

Principle of Range Finder Applied to Depth Gage

THE principle of the range finder, used in war time to determine the distance of ships and airplanes, can be applied to a special form of microscope and employed in the laboratory for minute and accurate depth measurements. This was demonstrated recently by Dr. I. C. Gardner, of the United States Bureau of Standards, before the American Optical Society.

He showed that the range finder consists of two telescopes with their main lenses some distance apart, but with their prisms arranged so that the observer sees the view through both telescopes at the same time. He sees the scene in circular form, divided across the center. The upper half is the view through one telescope, the lower through the other. When the prisms are so adjusted that the object being measured is not split in the center, the actual distance may be read off a dial.

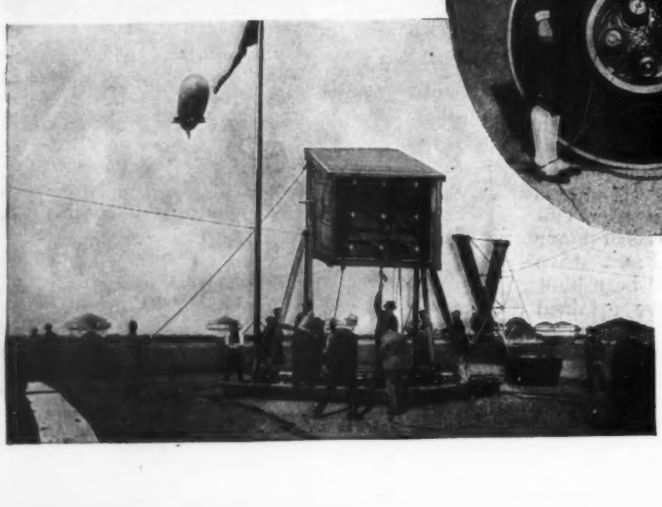
Now, the depth gage applies the identical principle, but two microscopes, instead of telescopes, are set at an angle of twenty-five degrees, so that both can be focused upon the same spot. The field also is divided, and when the instrument is set so that no break occurs, the depth can be measured to an accuracy of about one-ten-thousandth of an inch.

"Beams" of Sound to Guide Aircraft in Fog

A "SOUND searchlight," described as throwing out a concentrated "beam" of sound that penetrates high into the air, as a shaft of light cuts into the darkness, was tested recently at Camden, N. J. The device is expected to prove valuable in directing aircraft to landing fields during fog, when they have approached so close that the radio beacon has become ineffective.

The so-called "super-directional" horn was developed by S. T. Williams, of the Victor Talking Machine Company. It consists of a cluster of nine conical horn units each carrying a loudspeaker. They are joined into a single straight-sided mouth, forming a rectangular box about eight feet square and twenty feet long. This box is mounted on pivots which, in combination with the wheeled base, allow it to be pointed in any direction that may be desired.

During the test, the horn was mounted on top of a ten-story building and trained on the U. S. Army dirigible *J-4*, which circled overhead at an altitude of 1,500 feet. Officers of the airship reported they could hear every syllable of the directions spoken to them by men on the roof below. Further tests probably will be carried out soon with the Navy's rigid dirigible, *Los Angeles*.



Left: The "sound searchlight" talking to the crew of the U. S. Army dirigible *J-4*, 1,500 feet up in the air. Above: A unit of the great loudspeaker horn.

A giant phonograph, thirty-one feet tall, which could be heard thirty blocks away, was built by the same company not long ago and described in POPULAR SCIENCE MONTHLY. The unique feature of the new horn, which makes it an advance over the stentorian phonograph, according to the inventor, is that it concentrates the sound waves instead of allowing them to scatter. Thus, the sound "beam" can be trained upon an object high in the air and, like a searchlight, can follow its flight. Guide ropes manipulated from the roof tilt the horn up and down and from side to side.

Speeding Typists' Fingers with Radio "Jazz"

A PSYCHOLOGIST connected with a Pennsylvania college not long ago conducted an experiment in which typists with their typewriters, kettledrums, saxophones, and plain, everyday pots and pans were used to prove his contention that human beings work better and faster amid the din produced by modern industrial centers than in solitude and quiet surroundings, as generally believed.

He placed a dozen typists with their machines in one of the classrooms and bade them start a certain piece of work. After recording the time required to complete the job, he asked them to repeat the process. But this time a score of students with a variety of noise-making instruments were ushered in and began to make an ear-splitting din. The girls not only finished the piece of typewriting in shorter time, he announced, but also with fewer mistakes!

The same idea seems to underlie the recent action of the officials of the Brooklyn, N. Y., plant of the Bush Terminal Company, who have had a radio installed in the main office. The tuning-in of any feature is permitted during working hours, but jazz music is given the preference, because, as one of the officials puts it, "it makes the typists' fingers move faster!"

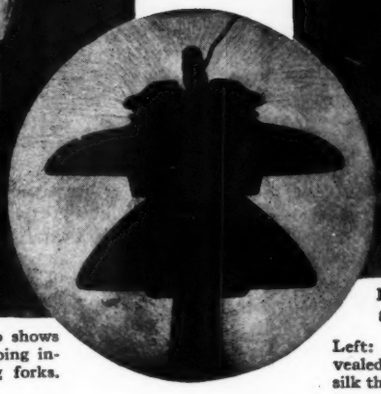
Screen Production Shows Motion of Planet

OUR neighbor planet Jupiter took the leading rôle, the other night, in a remarkable motion picture thrown on the screen in Washington, D. C. By an ingenious process, similar to that used in photographing budding flowers, its motions were so sped up that spectators saw Jupiter actually revolving, and one of its satellites or moons produce an eclipse before their eyes.

According to a plan worked out by Dr. C. E. K. Mees, of the Eastman Kodak Company Research Laboratory, successive exposures were made at regular intervals several minutes apart, on two or three nights. Then they were run off at standard movie speed, thus accelerating the motion enough to make it plainly visible. The pictures were taken by Prof. W. H. Wright through the telescope of the Lick Observatory.

Invisible Forces Photographed!

This spectacular night photo shows a 750,000-volt flashover jumping insulators in brilliant lightning forks.



Electric field around insulator in glass tank being photographed.

Left: An electric field as revealed by the camera. Tiny silk threads show lines of force.

FIRST photographs of the electric field around a conductor, made at Purdue University, promise to simplify enormously the problem of designing good high-voltage insulators and to aid in the study of what happens around a wire carrying electric current. They make it possible to see the direction of electric lines of force in the air that precede lightninglike discharge of sparks, replacing tedious calculations.

This "electric field" is normally invisible; but the investigators found that when they placed an electric cable or insulator in a glass tank filled with carbon tetrachloride, a transparent nonconducting liquid, and floated thousands of tiny shreds of artificial silk in it, the silk threads immediately lined up to give a perfect picture of direction of electric stresses. At the same time they showed along what path the current was most likely to jump off or to break down insulating material. A camera, set up over the tank, took pictures that will aid in making improved cables and insulators.

Tractor Sets 1,330-Mile Endurance Record

PLODDING along like the tortoise in the fable, a tractor, pulling a disk harrow over a thousand-acre field in California, set what is believed to be a world's record recently when it kept going for seventeen nights and days.

The test was made by engineers of the University of California. During its long run, the tractor covered 1,330 miles and disked 1,280 acres. The only times the wheels stopped turning were for short periods four times a day when the tanks were filled with gasoline and oil. The motor was not stopped.

The only mechanical difficulty encountered was the loosening of a valve push rod. This was adjusted without stopping. The fuel consumption was 1,151½ gallons; oil, 117½ quarts.

Walls Hide Radiators in Novel Heating System

SMALL hot water pipes, buried in walls, ceilings, and floors of the new British Embassy, under construction in Washington, D. C., will furnish a novel heating system that eliminates the use of visible radiators. This is believed to be the first time the system has been installed in a building in this country, although frequently used in England.

In some of the rooms all four walls and the ceiling will be warmed. In others, heating the floor is expected to make the room comfortable. The British officials in charge of the construction decided against the familiar radiator, which has been widely employed since it was invented in 1885, on the ground that it takes up too much space and gives a less uniform heating to the room than a system of invisible pipes.

Bolstering Up the Leaning Tower of Pisa

CONCRETE is being forced under the foundation of the leaning tower of Pisa in Italy, in an effort to save the famous medieval structure. The tipping of the tower has increased steadily, and fear was felt for its safety.

When measured a hundred years ago, the tower was fifteen and one half feet out of the perpendicular. In 1910, it was sixteen and one half feet. The foundation descends only ten feet into the ground. A recent survey was made of the subsoil underneath to see what strengthening measures could be undertaken. It was decided to force concrete under the walls, which are thirteen feet thick at the base.

The tower, with its eight stories, rises 179 feet, and is constructed throughout of marble. Experts who have studied it believe that the tower assumed its leaning position while under construction, early in the twelfth century, and that its designers did not intend it to lean.

Workmen are seen here forcing concrete under the foundation of the leaning tower of Pisa, in an attempt to prevent its collapse.

Tests Show Canary Bird Is Best Gas Detector

THE United States Bureau of Mines, after experimenting with chickens, rabbits, dogs, mice, and other animals, has reached the conclusion that the canary is the best detector of poisonous gas in mines. In this connection, it will be remembered that Dr. Hugo Eckener, builder and commander of the *Graf Zeppelin*, had his pet canary aboard for this purpose when the world's largest dirigible made its recent trip from Germany to America and back.

The canary's fitness for the job lies in the fact that it falls from its perch the moment it breathes dangerous gases, but revives quickly when brought into the fresh air. It seldom dies from the effects, and can be exposed and revived many times within a short while without harm.

In the Bureau of Mines test, canaries, white mice, chickens, dogs, pigeons, sparrows, guinea pigs, and rabbits collapsed in the order named when breathing a small amount of carbon monoxide.

Why Two Sets May Look Alike, But Behave Differently

By JOHN CARR

THE two men in the seat behind me were having a hot argument.

"You sure gave me a bum steer when you recommended that lemon," one of them growled disgustedly. "About all that alleged radio set has is a swell cabinet. The rest of it's a bunch of junk!"

"Junk nothing!" asserted the other man heatedly. "My set works fine, doesn't it? How can your set be junk when it's exactly like mine? You must have a bad tube or something."

The man with the grievance laughed sarcastically. "Yeah," he gibed, "it must be something, all right, but it sure isn't a bad tube. If all the tubes the dealer has tried in that set were laid end to end they'd reach from here to the middle of next March! The set's a flop, I tell you!"

I lost the rest of the conversation, for the train stopped just then and the two men got off. However, it's pretty safe to prophesy that the disgruntled chap will finally trade in or otherwise dispose of the unsatisfactory set and get another. And the new radio receiver undoubtedly will be of a different make than the old one.

Now what brought about this unfortunate incident? The fact that the two sets appeared to be identical would lead one naturally to believe that they should operate alike. Why, then, did they perform differently?

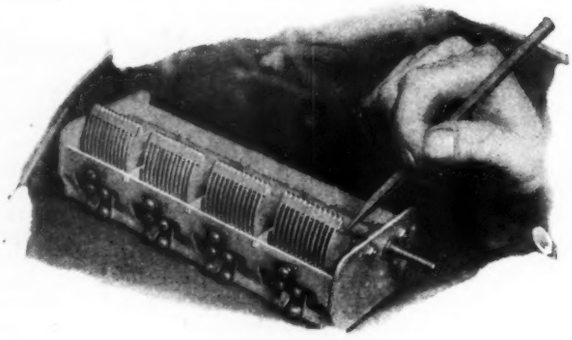
PREVIOUS articles in POPULAR SCIENCE MONTHLY have pointed out that location is all-important. A set that gives excellent results in one locality may not do nearly so well in another place only a short distance away. Every radio fan who has moved several times can testify to the variation in reception.

But aside from locality, there are other important reasons why radio sets that appear to be identical are not alike in performance.

The condition of the vacuum tubes in any set is so important that almost the first thing the service man does when he is called in to remedy trouble is to test the tubes. Obviously if one of two identical receivers is fitted with one or more tubes that are below par, and the other receiver has good tubes in every socket, there will be a great difference in results.

But even if the two receivers were fitted with good tubes, one of them might be, and often is, inferior as to sensitiveness and selectivity. Sometimes there is a pronounced difference in tone quality. The chief cause of such inferiority is lack of synchronization in the tuning of the radio-frequency stages. This breath-taking mouthful of words means, in plain language, that the parts of the poor receiver are lacking in "teamwork." Individually they may be stars, but collectively they don't work together.

You know, of course, that the weak radio impulse that reaches your set by way of the antenna is amplified or strengthened many times before it is converted into the electrical equivalent of sound that you can hear. This strengthening of the radio signal is accomplished by passing it through several circuits, each of which consists, essentially, of a vacuum tube, a coil of wire, and a queer-looking metal gadget with two sets of metal fins, called a condenser. You have noticed how some of these fins slide in between others without actually coming into contact, when you turn the knob that tunes the stations. Moving these fins, or condenser plates, governs the tuning of the individual stage of amplification. The same result could be obtained by changing the number of turns in the coil of wire, but it is mechanically more convenient to do the tuning by moving the condenser plates.



Even a slight flaw or a faulty adjustment in the plates of one of the condensers may result in inferior broadcast reception.

NOW when the parts of a radio receiver are not doing good teamwork, it simply means that the condenser plates are not all producing the same effect for any given amount of movement of the tuning control knob.

Sometimes the fins are not set at the same angle on the shaft, but more often the space between the moving fins or plates and the stationary ones is different in the different condensers. It takes only a slight error to cause trouble. The tiniest dent in one plate may be just enough to throw the tuning of that stage out of line with the other stages and result in cutting the sensitiveness of the receiver in half. And because the selectivity of a radio receiver, which is its ability to choose between stations, depends on the cumulative effect of several stages, this desirable quality may be seriously impaired.

OF COURSE, defects in the condensers are not always to blame for poor teamwork. Any irregularity in the winding of the coils will cause the same trouble.

For really satisfactory results, therefore, both the coils and the condensers must be manufactured with great accuracy; and since it would be extremely expensive to make them to precision standards, absolutely alike, some provision must be made for ironing out the slight differences after the set is fully assembled and ready for use.

And here is where mysterious differences occur. One set may be adjusted to get teamwork out of the parts, and another may not. The adjusting must be done by skilled workmen, and with radio sets selling at the prices that prevail this year, there naturally exists a temptation to slight this expensive but necessary adjustment.

In fact, several makes of receivers have failed to pass the tests of the Popular Science Institute of Standards because they were carelessly assembled.

A RADIO receiver is, after all, merely a piece of apparatus made of aluminum, brass, copper, iron, and various insulating materials, the total value of which as raw material is but a tiny fraction of its selling price. The remainder of the money that you spend pays for the manufacturing of this material into finished parts and for the handwork necessary to put these parts together properly and adjust them.

Now what can be done to make the parts do good teamwork if they are not working together? You, as the owner, can't do a thing about it unless you have a pretty fair understanding of the operation of each part. Lacking that knowledge, any "fiddling" you may do with the adjustments probably will result in making matters worse rather than better. And there is the chance, also, that the real trouble may be merely a matter of locality or poor tubes.

IF YOUR present battery receiver is of comparatively recent make and gives good results, revamping the outfit along modern lines may well be worth while, if you enjoy working with tools.

Rewiring for A. C. Simplified

Here You Can Learn When It Pays to Discard Batteries, and How to Change the Old Radio Set into an "Electric"

By ALFRED P. LANE

THOUSANDS of radio fans now are trying to decide what to do about their battery operated radio receivers. They ask: "Shall I get new batteries and keep on using my set as it is? Had I better scrap it and get a new electric model? Isn't there some way to make it over so it will be an electric?"

And the correct answer, curiously enough, may be either yes or no to any one of these three typical questions. It all depends on the particular set and the individual who owns it.

For instance, the receiver may be a very old one, poor in tone quality and obsolete in appearance. In such a case I would unhesitatingly recommend keeping the set just as it is until you can afford a whole new outfit, then scrap it and either buy or build a modern receiver. Don't waste time trying to revamp a really old receiver along modern lines. It doesn't pay. Too much has to be done to it.

On the other hand, the receiver may be of comparatively recent make and give its owner satisfactory results for distance, volume, and tone quality. In that case revamping the outfit along modern lines may be worth while or it may not, depending on the owner's ability to do the work involved.

Of course this problem cannot confront the man who lives where there is no electric light current. He must, perforce, be content with battery operation.

Don't expect to improve the operation of your radio set by rewiring it for full electric operation. A full electric set is neither more sensitive nor more selective than the same set operated by batteries. The tone quality will not be changed, but if you have been operating the set on ninety volts with 201-A tubes in all sockets, you can greatly increase the volume on local stations with good tone quality by using a power tube type 171-A in the last audio stage. If your receiver is now equipped with a 171-A tube in the last stage, its operation after rewiring for alternating current tubes should be as good but no better than the results you now obtain from batteries.

Certain types of radio receivers, either because of the circuit employed or the tubes for which they are designed, are not good subjects for A. C. rewiring jobs. Among these may be listed practically all types of reflex sets and superheterodynes designed for use with the 199 type of tube.

The simplest way to obtain full electric operation with such receivers is to use an approved type of A and B eliminator. And the reflex circuits may give trouble even with eliminators.

REWIRING for full electric operation with the modern A. C. tubes is most successful with the various types of tuned-radio-frequency and neutrodyne receivers, provided they are not fitted with resistance coupled amplifiers. It is, of course, possible to operate a resistance coupled amplifier circuit with alternating current, but the simple circuit here described cannot be used. If you have a set using resistance coupled amplifiers, I would recommend changing over to transformer coupled audio amplification so that you can use the methods outlined on these pages. Modern transformer coupled audio amplification will give practically as good tone quality as resistance coupling, and the principal advantage of resistance coupling, low B-current consumption, is of no importance in full electric operation.

THERE are many types of tuned-radio-frequency circuits, but they all boil down to a circuit similar to the one shown in Fig. 1. They may have fewer rheostats or even no rheostats of the hand adjustable type. The coils may be of different design, and there are many forms of balancing or oscillation control. The condensers may be lined up on a single control or they may be fitted to individual dials. The receiver may have six tubes instead of the five shown or it may, in the case of many home built receivers, have only a single stage of radio-frequency amplification.

These matters do not concern us in our rewiring job, for the method we will follow will work no matter how these details are arranged.

First you must get the necessary apparatus to perform the rewiring job. Here is the list:

A filament-heating transformer having three secondary windings giving 1½, 2½, and 5 volts. The 2½- and 5-volt windings must be center-tapped.

A high grade factory built or home assembled B-eliminator. (If you already have a B-eliminator that works well you

will not have to purchase another.)

A socket for type 227 tube (five-prong).

A six-ohm potentiometer (*P* in Fig. 2).

A wire wound fixed resistance (*R1* in Fig. 2. The value in ohms of this resistance is determined by the number of 226 tubes in the circuit).

A wire wound fixed resistance (*R2* in Fig. 2).

A high resistance, noninductive, noncapacitive potentiometer (*V* in Fig. 2).

A one-microfarad by-pass condenser (use as explained below).

A supply of wire. Ordinary double cotton, paraffined bell wire will do, but the regular insulated radio hook-up wire is much better.

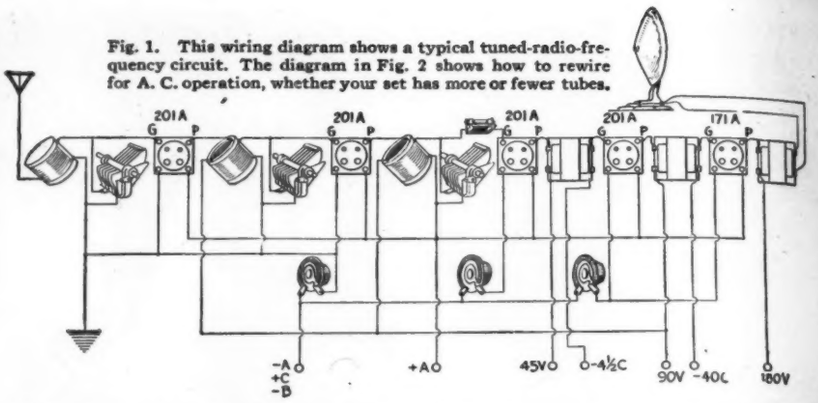


Fig. 1. This wiring diagram shows a typical tuned-radio-frequency circuit. The diagram in Fig. 2 shows how to rewire for A. C. operation, whether your set has more or fewer tubes.

THE first job in the rewiring is to determine which tubes are connected in the various stages. If the receiver is home built, you can settle this question by referring to the diagram you used in wiring it. If it is a commercial set, there probably will be marks on the subpanel near each socket that will give you the desired information. The markings are abbreviated to "1st RF", "2nd RF," "Det," "1st AF," and so on.

In any case your job is to locate the detector socket and the second or last audio socket. Sometimes, instead of marking the stages, the type numbers of the tubes which should be used are indicated. If the set is arranged for a type 171 tube in the last socket, there will be some marking to indicate this fact.

The detector socket always can be identified by the grid condenser and grid leak, which always are connected as close to the grid terminal of the socket as the arrangement of the apparatus will permit. The grid condenser is a small fixed condenser fitted with clips which hold the tubular grid leak.

WHEN you have definitely located the detector tube socket, replace it with the five-hole socket, as shown in Fig. 2. Note that the connection to the grid condenser and that to the *P* terminal of the first audio transformer are simply removed from the old four-hole socket and attached to the similarly marked binding posts on the new five-hole socket. Run a wire from the terminal of the new socket marked *K* to the nearest point on the wire leading from the metal frame of the variable condenser that tunes the detector circuit. By carefully comparing the wiring in your receiver with Figs. 1 and 2, you will see how to do this.

The next step is to cut away all the filament wiring from the sockets. It is not necessary to remove this wiring from the receiver. In fact it should be left in place. Merely clip each wire at the socket terminal and then clip off a short piece of it so that there will be no chance of the loose end making an accidental contact. Also make sure that the wires will not sag and short circuit against some other wires in the set.

NOW connect two long pieces of wire to the two *H* terminals of the new socket you have installed for the detector tube, and twist these wires together like an ordinary twisted electric light cord. The other ends of the wires should be connected to the 2½-volt binding posts on the filament heating transformer, as shown in Fig. 2. Repeat the same operation for the socket that takes the 171A power tube, the last audio socket. As shown in Fig. 2, this twisted pair is connected to the 5-volt binding posts on the filament-heating transformer.

In the diagram of Fig. 2 there are three sockets marked for 226 tubes. In your set there may be only two if the set has only one stage of radio-frequency amplification (the usual four-tube set), or there may be four or even five if the set has a total of six or seven tubes.

It makes no difference how many 226 tubes there are. They should all be wired in parallel and connected to the 1½-volt binding posts of the filament-heating transformer, as shown in Fig. 2. This completes the actual filament wiring. You can check your work up to this point by inserting the tubes in the sockets and putting the plug from the filament-heating transformer in the nearest electric light socket.

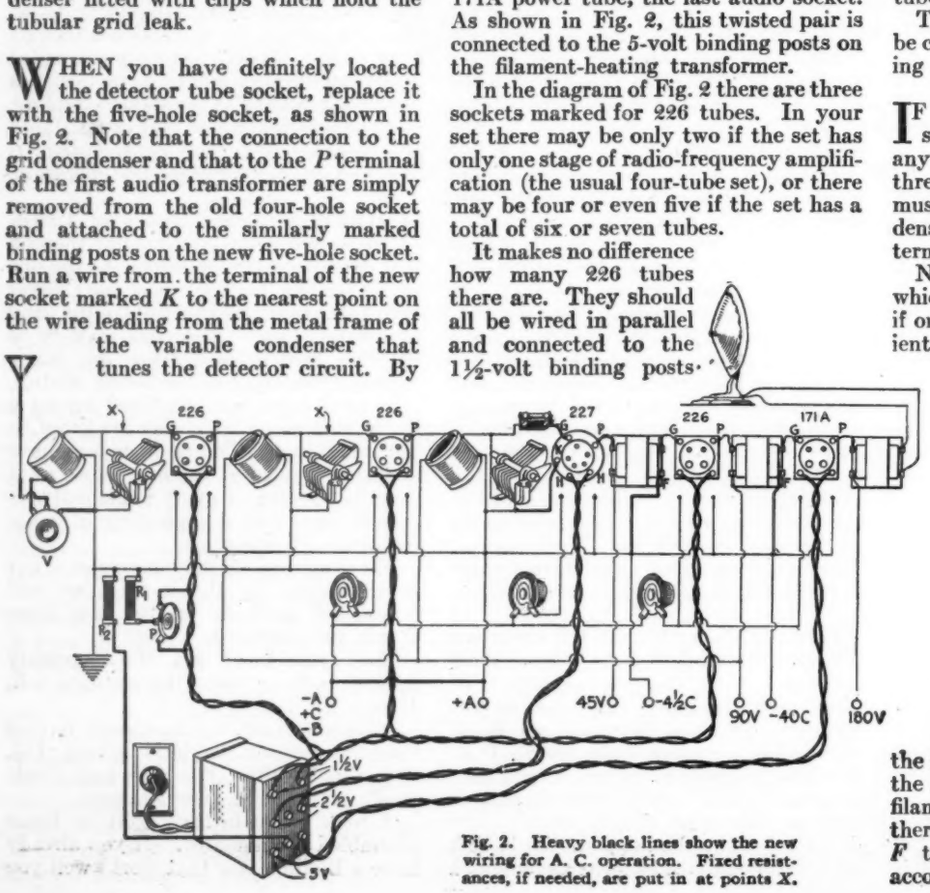


Fig. 2. Heavy black lines show the new wiring for A. C. operation. Fixed resistances, if needed, are put in at points *X*.

The next step is to connect the minus-A and plus-A binding posts together with a piece of wire. Then mount the potentiometer *P* at any convenient point back of the panel and connect the outer terminals to the wires leading from any socket in which a 226 tube is to be inserted. Be careful that you do not connect both wires from the potentiometer to the same socket wire. It is easy to make this mistake because the wires from the sockets are twisted together.

Now connect the center terminal of the potentiometer to one end of resistance *R1*. This resistance should have a value of 1,000 ohms if there are two 226 tubes in the receiver, 700 ohms for three 226 tubes, or 500 ohms if there are four 226 tubes.

The other end of resistance *R1* should be connected to the original filament wiring at the nearest convenient point.

IF THERE are only two 226 tubes in the set you may be able to get by without any by-pass condenser across *R1*, but if three or more 226 tubes are in the set you must use a one-microfarad by-pass condenser connected directly across the terminals of *R1*.

Now connect one end of resistance *R2*, which should have a value of 2,000 ohms if one 171A tube is used, to any convenient point on the original filament wiring.

The other end of resistance *R2* should be connected to the center terminal of the five-volt winding on the filament heating transformer.

The two resistances *R1* and *R2* are required to supply the necessary C-bias voltages on the radio- and audio-frequency amplifier tubes.

In some receivers, the *F* terminals of the audio-frequency transformers are connected to binding posts so that C-voltage may be applied. The diagram of Fig. 1 shows this arrangement. On other sets not using a C-battery, the *F* terminals of the audio transformers are connected to the minus side of the filament wiring. As shown in Fig. 2, the *F* terminals are connected to the old filament wiring at the nearest point. If there is any doubt about which are the *F* terminals, the same result can be accomplished by (*Continued on page 149*)

Timely Hints for the Radio Fan

A Useful Transformer Test

Headphones Aid in Fixing Position of Instruments to Avoid Coupling Trouble—Measuring the Life of a Storage Battery

THE audio transformer, as every radio experimenter knows, consists of a metal core made up of many layers of thin transformer steel on which are wound the primary and secondary windings. And there is no difference in principle between an audio transformer and the power transformer used in the modern electric radio receiver.

All alternating current transformers operate by electromagnetic action. In use, the core of the transformer is surrounded at all times by magnetic lines of force. Of course, with the usual closed core type of transformer, this external magnetic field is relatively very weak, but in the sensitive circuits of the audio amplifier end of a radio receiver, these weak external fields may cause considerable trouble.

There is even more chance for trouble in the modern full electric radio receivers, especially if the external field of the power or filament-heating transformer is acting on the core of one or both of the audio transformers. In such a case there will be a noticeable hum from the loudspeaker no matter how carefully the other parts of the circuit are worked out.

The rule-of-thumb method of setting audio transformers so that they will not couple together is to place them with the cores at right angles. This rule is a good one, and so is the caution to have the transformers as far apart as the layout will permit.

However, there is a simple method by which you can find just how to set any two transformers so that there will be no interaction between them

Using headphones to determine positions for transformers where the hum disappears.

NO APPARATUS is required except an ordinary pair of headphones. Assuming that you have 110-volt alternating current available, connect the ends of a drop cord to the primary winding of one transformer and insert the plug in the nearest electric light socket. Then connect the tips of the headphone cord to the primary or secondary terminals of the other audio transformer.

Now place the two transformers close together and you will find that you can hear a noticeable hum in the headphones. The illustration on this page shows a test of this kind being carried out in the laboratory of the Popular Science Institute of Standards.

As you move one or the other of the transformers you will notice that the intensity of the hum changes, and you will be able to find several positions for the transformers where the hum entirely disappears.

Of course the advantage of making such a test is that you can place the transformers so near each other that they are almost touching, and yet have no interaction.

The same method can be followed to find where to place audio transformers so that they will not be affected by the power or filament-heating transformer. Simply plug the power or filament-heating transformer cord into the light socket and connect the headphone cord tips to the audio transformer.

In fact, this method will prove useful at many points in laying out apparatus for home constructed radio receivers and power or B-eliminator units. Audio-frequency choke coils, for instance, can be so placed in a B-eliminator circuit that there will be no interaction to reduce their effectiveness in filtering out the alternating current hum.

You can apply 110-volt alternating current to the primary or secondary of any audio transformer or to the terminals of any B-eliminator choke coil without danger of burning out the winding if the terminals of the remaining winding are left unconnected. A piece of wire connected across the terminals of one winding, while 110 volts alternating current is applied to the other, will result in a burn-out, of course.

A B C's of Radio

WHILE alternating current operation, as compared with battery operation, affords no better results in the radio-frequency detector, and first audio stages of a receiver, it is a big help in the last audio stage.

Working from an alternating current source, you can easily obtain the necessary high B-voltages required for best results when you use modern power tubes. And these tubes definitely improve tone quality, especially when you want plenty of volume.

Of course, any desired B-voltage can be obtained from B-batteries if you use a sufficient number of them connected in series, but this becomes an expensive method if you go beyond 180 volts.

When Batteries Play Out

AN OUTSTANDING characteristic of the lead-acid type storage battery as used in all automobiles for starting and lighting, and as the A-battery to supply filament current for a radio receiver, is the remarkable service it gives while it is reasonably new. It will stand around for weeks at a time partly charged and, perhaps, with the water level below the tops of the plates, and yet give good service.

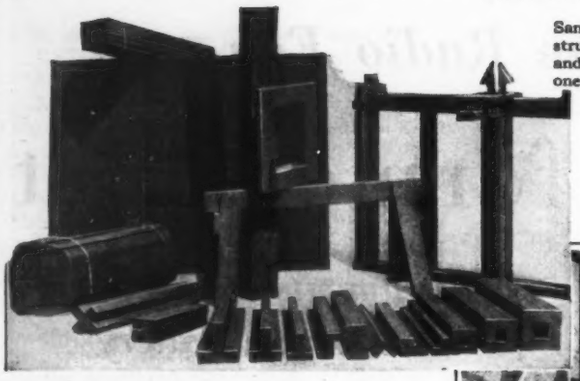
The day of reckoning comes rather suddenly. Some evening the radio goes dead, and you discover that the battery is completely discharged. Then, after you give it a long charge, it works well for a time, when the same thing happens again.

From then on, life seems to be one continual round of having the battery charged and having it go dead just when you want it most.

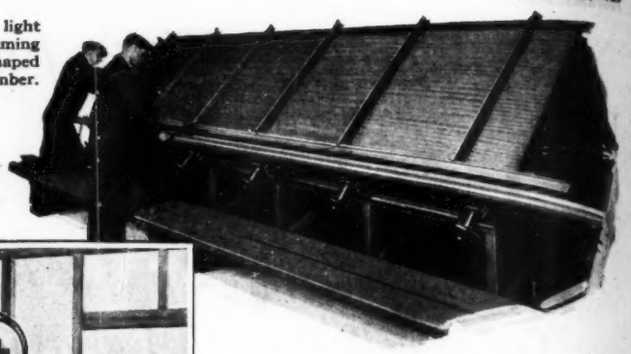
The useful life of any storage battery is governed by the care you give it. It may last less than a year, or it may give four or five years of good service. But no matter how careful you are, it won't last much longer than five years.

When a battery must be charged every two or three days even when not used, it has outlived its usefulness and should be replaced. No amount of charging or attention will bring a decaying storage battery back to life again.

To prolong the life of your storage A-battery, do not let it become discharged below 1,200 on the hydrometer. It is better to give it a small charge once a week than to let it go two weeks between charges.



Samples of light structural framing and trim of shaped one-piece lumber.



This special "loom" makes flooring out of waste strips left from cutting the new lumber.

Fabricated Lumber Cut in Labor-Saving Shapes

"WHY cut a tree to pieces and then pay a carpenter money to put it together again?"

That is the pertinent question put by Ross Houston, veteran lumberman of Tacoma, Wash., who recently developed and patented a unique labor-saving plan for sawing logs. His system produces "fabricated" or shaped lumber instead of flat boards and square beams, now the standard product of lumber mills.

Just as steel girders are formed for convenience in "I" and "T" shapes, Houston cuts boards in one-piece slabs in L's, X's, and T's—each for a special purpose. He claims striking economies for his solid lumber shapes.

For instance, the post at the corner of an ordinary dwelling is usually made, today, by nailing together three two-by-fours. The Houston house corner, a solid beam with a cross section resembling a humped letter "L," has ample nailing surface but contains a seventh less lumber. That means a saving of wood and of freight charges, besides eliminating the usual nailing. A window frame now requires eight pieces of lumber and as many outside joints; but four of Houston's "L's," without outside joints or nailing, suffice. Other shapes are conveniently adapted for partition tees, table tops, fence caps, and crates. There are four hundred possible shapes so far.

Installing one-piece fabricated partition tee. Insert shows cross section of house corner.

The inventor plans to introduce his new system in lumber mills throughout the country. The one-piece slabs, he says, are as strong as nailed shapes and do not crack or warp.

Profits from use of his labor-saving material, Houston says, offset many times the slight added cost of making it at the sawmill. The secret of its manufacture is simple. Sawing at angles into a log, instead of straight from the side, gives the whole variety of shapes. The corner post is made by setting the saws at right angles to each other.

Houston has worked out diagrams showing how to get the most in shaped lumber out of a single log. He even saves the waste, thin half-round slabs left from the cutting. They are slit into narrow strips and glued together to make flooring material on a special "loom" or gluing press that he has invented, capable of turning out 150 feet a minute.

"Lightning" in Auto Motor

JAGGED forks of miniature lightning flash in the cylinders of your automobile every time an explosion takes place. This was revealed by recent experiments conducted in the Aeronautic Research Laboratory of the Massachusetts Institute of Technology, Cambridge, Mass.

The action that takes place within the cylinder of a motor when the gas explodes was observed by the experimenters through a thick piece of fused quartz, fixed in a plug in the cylinder. They report that the action takes place in three "acts." First there appears the bluish light of the sparks, then the jagged flashes, and finally the brilliant glow of the gas explosion.

Stunning Gowns of Metal Soon May Be the Style

IF EXPERIMENTS made recently by German manufacturers prove practicable and popular, women soon may go to dances and the opera in stunning evening gowns of metal, while their escorts will be clad in a modern adaptation of the suits of armor worn by knights of old.

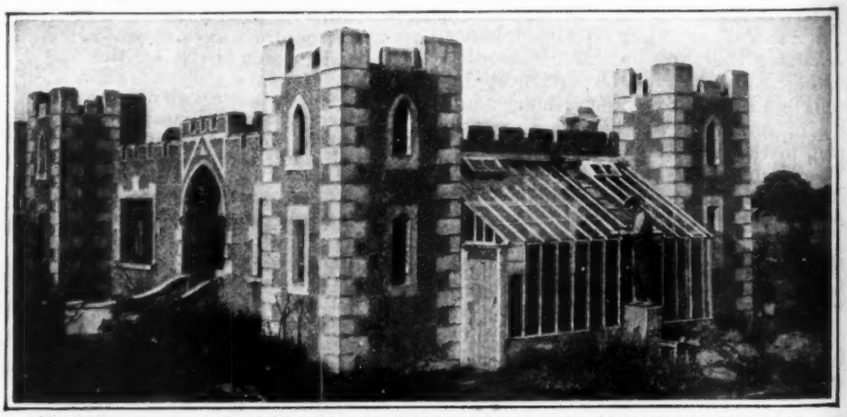
Flexible fabrics containing layers of metallic foil have been perfected; and the next step, the German experts declare, will be the making of clothes of aluminum—waterproof in wet weather and heat-proof in summer, like the aluminum paint on the exterior of a Zeppelin dirigible.

Thin sheets of aluminum, resembling tin foil or gold foil, are coated on both sides with protective material not unlike the plastic substances used in manufacturing rayon. This fabric is said to be almost as light as silk, tough as leather, waterproof as rubber, and bright and heat-reflecting as aluminum. Of this material, raincoats, umbrellas, and even dresses and business suits may be made.

Not only striking frocks for women, but also beautiful effects in household decoration will be obtainable in the new fabrics, the experimenters predict.

He Built His Own Castle—On the Ground

A PRIVATE little castle, complete with towers and battlements, as well as a conservatory for raising flowers during winter months, has been constructed by T. Martin, a chauffeur in Hookwood, Surrey, England. During a period of unemployment, he planned and built the unique dwelling, making with his own hands all of the concrete blocks which went into its walls. It took eleven months to complete the imposing structure, from the foundation to the finishing touches on the conservatory. The unusual building, patterned after medieval architecture, has been given the name of "Hookwood Castle" by people living in the vicinity.



The builder is seen at the right putting the finishing toûches on the glassed conservatory of the remarkable little castle he constructed with his own hands. He did the job in eleven months.

New Experiment Confirms Findings of Einstein

PROF. A. A. MICHELSON, University of Chicago physicist, has just repeated his memorable experiment of forty years ago, which later served as the basis of the much-discussed Einstein theory of relativity. The results, recently announced, completely confirm the test he then made with the aid of the late Prof. Edward W. Morley.

The Michelson-Morley experiment, which has been the subject of the most heated scientific controversy, was intended to discover whether there exists a hypothetical "ether," through which the world moves. Two beams of light were made to run a race. They were shot out at right angles to each other, reflected back to their source, and their arrival timed. Had one beaten the other, an "ether drift" would have been proved, but a "dead heat" which actually resulted could not be explained until Einstein proposed his remarkable theory.

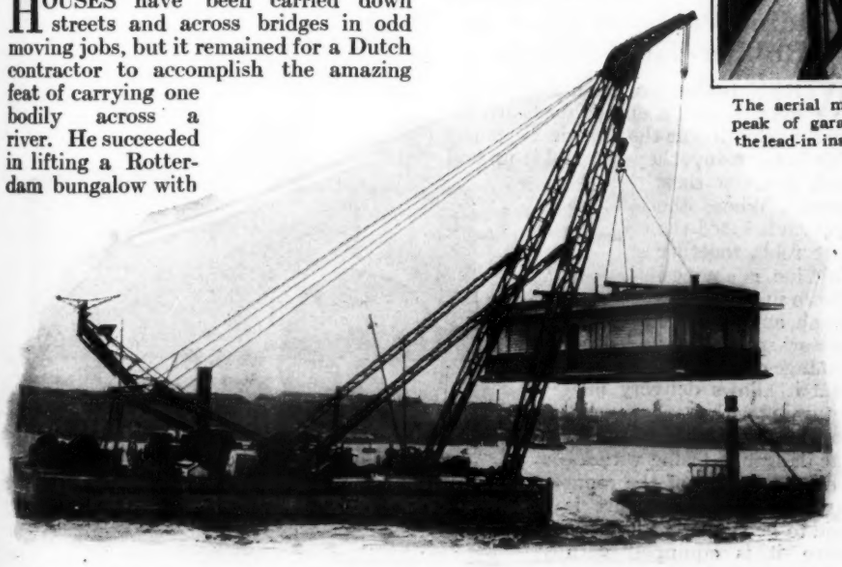
New experiments conducted on Mount Wilson, Calif., with instruments ten times as accurate as the first, vindicate both the former experiment and Einstein's findings. That Einstein was fortunate enough to make a correct theory grow from wrong assumptions at the beginning, is Prof. Michelson's conclusion.

Amazing Machines Do Work of an Office Force

AN ALMOST complete "automatic office force" was included in exhibitions at the National Business Show, held recently in Chicago. One electric typewriter can be set copying an original letter and will keep on turning out duplicates until stopped. Among the automatic calculators were machines that subtract, multiply, and check their answers, and an amazing apparatus said to solve problems in algebra, geometry, and trigonometry. A mechanical clerk posts ledgers and statements.

Suspended by Crane, House Rides across River

HOUSES have been carried down streets and across bridges in odd moving jobs, but it remained for a Dutch contractor to accomplish the amazing feat of carrying one bodily across a river. He succeeded in lifting a Rotterdam bungalow with a huge floating crane and ferrying it across the River Maas to its new location without injury. Extreme care was required to keep the house from breaking apart. The structure was firmly braced with cross girders, two of which, fastened above the roof, served for anchoring lifting cables.



How the floating crane picked up a bungalow and carried it across the Maas River in Holland. Steel cables from the crane were fastened to cross-girders attached above the roof of the dwelling.

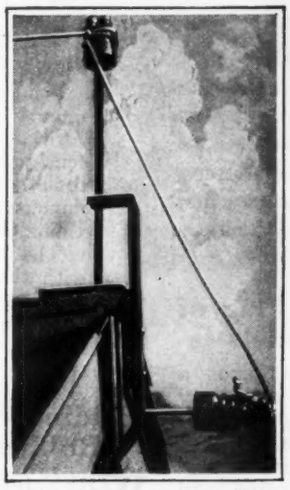
Put Milk in the Dark to Keep It Fresh

EXPERIMENTS by the Bureau of Dairy Industry of the U. S. Department of Agriculture show milk must be kept in a dark place to retain its flavor and freshness.

When exposed to sunlight, milk quickly develops "a linseed oil odor and a cardboard taste," the chemists found. This is because the light acts as a catalyst, causing oxidation. Of duplicate milk samples used in the test, those kept in the dark developed no off flavors or odors, even after seven to nine days, during which they remained fresh at a near-freezing temperature. Samples kept at the same temperature in sunlight developed unpleasant smell.

Handy Radio Aerial Mast Clamps to the Roof

DESIGNED to clamp on chimneys, around gutters and eaves, on apartment house parapets, or on window sills, a new radio aerial support has been put upon the market. Instead of nailing sticks to the roof or fastening them to the chimney to hold up aerials, radio owners can save time and trouble, says the inventor, by use of the new clamp, which supports an upright metal rod surmounted by an insulator. When the support is screwed solidly in place, a second insulator for the aerial "lead-in" can be inserted in a threaded hole in the side.



The aerial mast clamped to peak of garage roof. Note the lead-in insulator attached.

"Fountain Pen" Pistol Can Shoot Deadly Bullets

A "FOUNTAIN PEN" that spurts thirty-eight-caliber bullets was picked up near a street corner in New York City recently and turned over to the police. The tiny weapon, little longer than the width of a man's hand, is shaped to appear merely a harmless writing instrument. A few feet away, it would be mistaken for a real pen. Only when it is examined closely does the open muzzle at one end reveal its dangerous character.

A comparison between the dimensions of the strange weapon and the missile that it shoots is being made by the two officers in the picture. The pistol unscrews in the middle to insert the cartridge. It is fired by pressing a small button, about the size of a pinhead, in the end of the weapon. This releases a spring that operates the firing pin.

Urge Metal Storage for War Needs

THE ancient Assyrians stored huge quantities of iron in times of peace to have a plentiful supply for the manufacture of arms to be used in their frequent wars.

A similar method is advocated by U. S. Army officials for present-day America. There are nine minerals, they say, of which this country would not possess sufficient stores in case of sudden hostilities. These are manganese, which forms an alloy with steel and hardens it; antimony, which hardens lead; chromium, another steel alloy; platinum, used in chemical processes; nickel, needed for armor plate and bullet jackets; quicksilver, used in explosives, thermometers, and for several other purposes; tungsten, needed in the manufacture of electric lamps and machine tools; tin, principally used by the Army and Navy as a coating for cans; and nitrates, required in the making of artificial fertilizer.

Nobility Not Degenerate, Genealogists Assert

IN 1385 two English barons, meeting casually during the invasion of Scotland, discovered to their discomfiture that they bore the identical family colors. Each hotly disputed the other's right to them, and a long drawn out battle followed before a court of chivalry.

This fight, known in English history as the Scrope-Grosvenor suit, marked the beginning of the science of genealogy, which has been occupied with the tracing of lineages ever since.

In this country, genealogy is a comparatively new pursuit, but there is an organization, known as the American Genetic Association, whose members devote themselves to this interesting study, which has proved a great aid to historians.

At a recent gathering of the Association in Washington, a prominent genealogist declared that, contrary to popular impression, royalty and old families do not die out because of their age, or become degenerate and sterile on account of wealth and power. The fact that certain distinguished names no longer appear in the British peerage, he said, is due to a preponderance of female descendants.

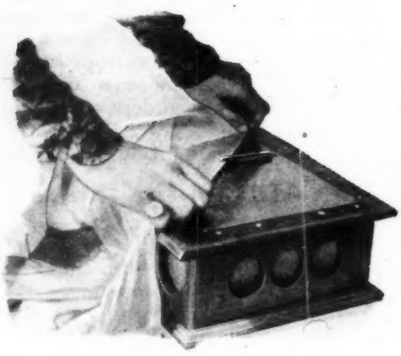
He Made American Flag of 33,000 Wheat Kernels

GLUING kernels of wheat upon a board for the equivalent of seventy working days, twenty-two-year-old Theophile Casaubon, of Los Angeles, produced this reproduction of the American flag. He used 33,000 kernels of selected hard wheat in the process.

The flag is four feet long and two feet five inches wide and is set in a background of natural colored wheat kernels. Each of the colored grains of wheat had to be dipped in oil paint three times to obtain the proper shade before it was glued in place. All of this painstaking work was done with just a single tool—a pair of small tweezers.

Would Foil Bank Robbers

A CAGE for bank tellers and cashiers, constructed with shutters which could be closed instantly by bank officials by a push button on the approach of a holdup man, was proposed recently to prevent bank robberies. The idea was advanced by an expert in such matters—a holdup man serving a life sentence in the Iowa State Penitentiary!



A Mechanical Substitute for Tailor's Shears

INSTEAD of snipping along a line with scissors, tailors can cut out clothes in a fraction of the time, it is claimed, by use of the new mechanical cloth cutter pictured above. The machine is housed in a small box, above which a guarded blade protrudes. The device is started by simply plugging into a light socket and turning a switch.

The material, marked with chalk to guide the cutting, is fed to the guarded blade, which cuts rapidly along the line at any angle or curve. The inventor believes the machine will prove valuable to tailors and small manufacturers by reducing the time necessary to cut garments.

New Comet Discovered by an Amateur

AN AMATEUR astronomer living at Rosebank, a small community near Cape Town, South Africa, distinguished himself recently by the discovery of a new comet. His "find" was confirmed immediately by officials of the Union Observatory in Cape Town.

The comet could not be seen with the naked eye. It traveled slowly, and had no tail. The astronomers of the observatory plan to name it the Forbes comet, after its discoverer, and as encouragement to amateurs.

Folding Pushcart Runs on Rubber-Tired Wheels

WHEN tradesmen finish making deliveries with a unique pushcart, recently exhibited at the Leipzig Technical Fair in Germany, they can fold it up and tuck it under their arms. When the bottom is lifted the cart folds together in the manner shown in the photograph, and may be stored in a narrow space. An added advantage of the new vehicle is that it allows delivery men returning with empty wagons to walk on sidewalks, out of the danger of traffic without taking up most of the room on the walk. The cart is said to be virtually noiseless, since it is equipped with rubber-tired, ball-bearing wheels.

Europe May Soon "Eat" Its "Drinks" in Solid Form

COUNTRIES now "wet" may soon go "dry" or partly so, but not as a result of international prohibition.

The taking of "beverage" alcohol in solid form—in other words, the "eating" of "drinks"—has been made possible through a new German invention, which was demonstrated at one of the principal laboratories in Berlin a few weeks ago.

Alcohol in solid form is an old story to the chemist, but heretofore the chemicals used to turn it into a solid mass were inedible and often poisonous. But the new German material is reported to be non-injurious and without taste or odor. Technically known as potassium-alpha-diacetone-fructose-sulphate, it is nothing more or less than fruit sugar treated by a process, the secret of which is jealously guarded by its inventors.

The principal commercial benefit to be derived from the invention will be the greater ease with which alcohol and alcoholic liquids—such as the bases of many drugs and toilet preparations—can now be stored and transported.

Gives American "Talkies" Foreign Tongue

WHEN the "talking movies" first made their appearance, some leaders in motion picture affairs asked, "Won't this innovation seriously curtail the export of American-made films to foreign, non-English-speaking countries?"

Edwin Hopkins, a New York playwright, has supplied the potential answer with an invention which he calls "vivigraphic films," which makes it possible to connect a voice record of an actor speaking in a foreign language with an American moving picture film. The adjustment effected by the new device, its inventor claims, is so delicate that synchronization between the foreign sounds and the American lip-movements on the screen is almost perfect.

Another benefit is that popular movie stars who look much better than they sound need not lose their jobs. In such cases, the "vivigraph" would supply the voices of actors or actresses who sound better than they look.

When the peddler has disposed of his wares, he simply folds the new rubber-tired cart and lugs it home under his arm.

With endless tread fitted over rear wheels, the new motorcycle can cross rough land.

Three-Wheeled Motorcycle Runs on Endless Tread

A MOTORCYCLE in which two small, doughnutlike wheels replace the single large rear wheel has been designed in England for use in rough country and on unimproved roads. An endless tread is placed over the two rear wheels to furnish traction over especially difficult trails. The tread can be removed from the wheels and carried in the repair kit, after a difficult stretch has been crossed, just as a motorist can remove his tire chains when solid road is reached. Extra large balloon tires absorb much of the shock of the bumps.

The machine is designed for the use of army and colonial officers stationed in undeveloped parts of the British Empire.

Tiny Ocean Plants Build Houses of Health Glass

IN THE Antarctic regions now being explored by the Byrd expedition live billions of microscopic plants which build transparent houses for themselves of materials so rare and difficult to manufacture that King Crœsus himself would have been too poor to fashion even a small palace from them.

The tiny plants, known to botanists as diatoms, construct miniature shells from silica and quartz which they extract from the sea water, in every square inch of which they live by the millions. When they die, their little "houses" sink to the bottom, and so numerous are the little plants that this material covers the ocean floor for a half million square miles.

The same substance has been smelted by electrical engineers in the making of lenses and of window panes which admit the sun's ultra-violet rays. A small window consisting of this transparent quartz is worth several hundred dollars.

Paints First Scientific Portrait of Spectrum

WITH the assistance of Dr. Irwin G. Priest and other scientists of the U. S. Bureau of Standards, Charles Bittinger, a noted artist of Boston, Mass., has painted what is considered the first scientifically accurate "portrait" of the spectrum of the sun.

In one of the laboratories of the Bureau, the scientists assisted Bittinger in selecting the colors that most accurately represented the spectrum. The spectrum copied in the painting was obtained by passing sunlight through a grating consisting of thousands of fine lines scratched on a polished metal surface. A glass prism is often used instead of a grating to form a spectrum.

Landmarks Guide Pigeons Home?

CONTRARY to accepted belief, bees, carrier pigeons, and other "homing" animals have no innate sense of direction, according to Armand Rio, a French naturalist. They find their way back to their hives or lofts by familiar landmarks which they memorize by short excursions within eyerange of their starting point before they set out on their flights, he says.

The carrier pigeons which make the longest flights are the ones with the keenest eyes, the best memories, and the greatest flying endurance. Ants find their way to their nests by remembrance of landmarks, he adds; and the same has been observed of barnacles under water, though these depend largely on touch.

Find Rare Handwork of Cave Men Jewelers

THE Neanderthal man, pictured by scientists as a flat-skulled, somewhat apelike individual who wooed his bride with a stone club, was a craftsman of no mean ability. Equipped with flint tools of the roughest and most primitive description, he nevertheless turned out articles for his daily use so delicately wrought as to challenge the skill of the most accomplished modern artisan.

Evidence of his proficiency was recently found in the shape of two rare scraper knives fashioned from rock crystal that were unearthed by the American School of Prehistoric Research party which has completed excavating the rock shelter, Abris des Mervilles, located in the Dordogne region of France at Castel-Merle.

These prehistoric implements, scientists say, are tens of thousands of years old. One of them is made of topaz of such beauty that it is a jewel as well as a weapon. The other, though not so fine in color, is of a workmanship which no living worker in quartz could rival.

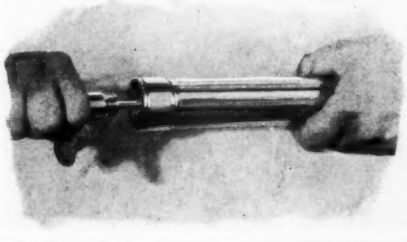
The discoveries were made by Professor and Mrs. George Grant MacCurdy, of Yale University, and nine students.

Novel Card Table Serves Also as Movie Screen

A CARD party can be changed into a movie show merely by lifting the top of a new card table, switching out the lights and turning on the home projector. The table is designed to serve as a motion picture screen when it is not in use in its ordinary capacity.

The top of the table is formed by two thicknesses, one on top of the other, and hinged at one side. The upper layer swings up, its under side forming the screen. It is held solidly in position by a stay while the pictures are being shown.

The table can be folded easily and occupies little room when stored away.



Pushing the plug into a socket at one end completes the electric circuit and fires the charge.

Dry Cell Blasting Device Resembles Flashlight

FUSES, for blasting, are supplanted by a new device which resembles an ordinary flashlight and furnishes electric current from three dry cells to discharge the explosive. According to the makers, it eliminates the danger of misfires and delayed fires caused by fuse trouble.

The firing unit of the device is a special plug to which are attached wires leading to the blasting cap. To fire the blast, it is necessary simply to insert this plug in a small socket in one end of the device and hold it there, exerting pressure against a spring inside, thus closing the electric circuit. Releasing the plug breaks the circuit. A ring at one end of the case makes it possible to hang the blasting unit at the belt.

Swinging Auto Crib Rocks the Baby to Sleep

BUMPS and jolts on rough roads rock the baby to sleep instead of disturbing him, when he is riding in a new automobile crib, according to the inventor. The crib hangs, hammock fashion, in the rear of the car, supported by two hooks screwed into the crossbeams of the car top. The heavy duck cloth of which it is made is held in rigid shape by plywood bottom and a wire frame. The height of the crib above the floor is adjusted through chains by which it is hung from the hooks.

A spring cushion in the bottom is made in three hinged sections, which can be adjusted to give the proper support whether the baby is sitting or lying down. The total weight of the apparatus is six pounds. It may be placed to one side in the rear of a closed car, as in the photograph, or it may be hung crosswise just behind the front seat. In an open car which has a metal top frame, it can be attached to the frame by means of straps.

The crib can also be hung from a stand on lawn or porch as an ordinary sleeping crib, or attached to the ridge pole of a tent or a tree limb to provide a comfortable sleeping place for baby when camping.

One Time in Five It's the Train That Is Hit

IN ONE out of five grade crossing accidents, the automobile crashes into the train instead of the train hitting the machine, announces the American Railway Association, summarizing the annual toll of such accidents. In many cases the drivers first crashed through the crossing gate before hitting the train. During 1927, says the report, there was an increase of sixty-six grade crossing accidents over the twelve months preceding.

Road Signs Teach Geology

SIGNS placed along the highways near Ardmore, Oklahoma, call attention to interesting geological formations along the road, giving the kind of rock and the age it represents.

One signboard contains a diagrammatic cross section of the Arbuckle Mountains, over which a main highway climbs. In constructing this road, many ledges were blasted away, revealing the rock formations. These serve as illustrations for which the signs form a text. Oklahoma is particularly interested in geology because its annual income of $500,000,000 from petroleum products is largely due to the efforts of workers in this particular field of science.

Closed Car Has Removable Top to Admit Sunshine

A CLOSED car with a top that can be folded back to admit, through glass windows, the beneficial rays from the sun, was one of the exhibits of a recent automobile show in London, England. By moving a handle at the right of his seat, the driver can push back the canvas cover of the car like a curtain, exposing a roof of health glass. Thus the occupants enjoy the equivalent of riding in the open, while still protected from wind and cold. The device also provides sight-seers with a view of mountain tops or city skyscrapers.

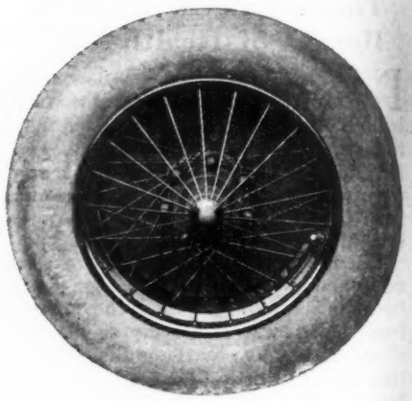
The driver, by pulling a handy lever, rolls back the canvas top of the car, exposing a glass skylight.

Holland Tunnel Handles 8,500,000 Cars in a Year

EIGHT and a half million automobiles, carrying 42,000,000 passengers, passed through the Holland Tunnel, under the Hudson between New York and Jersey City, during the first year of its operation, officials report.

Some of the elaborate tests made before the tunnel was built to insure against carbon monoxide poisoning have been revealed by A. C. Fieldner, of the U. S. Bureau of Mines. When the tunnel was proposed, it was suggested that a steady stream of cars might give off more carbon monoxide than could be carried away. The Bureau of Mines constructed an experimental tunnel, 400 feet long, in a mine near Pittsburgh, Pa. Small automobiles ran back and forth in it for hours while tests revealed the best method of introducing fresh air and removing contaminated air. The most efficient method was found to be admitting the fresh air at the bottom and removing the poisoned air at the top. This system was applied to the Holland Tunnel.

An automatic device that analyzes the carbon monoxide content of the air, and rings a bell and flashes a light if it becomes more than the safe limit of four parts in 10,000, was developed and installed in the tunnel. Besides, a series of fourteen instruments, placed at the ducts leading away the contaminated air, automatically record the poison gas content. If the records show more than two and a half parts gas to 10,000 parts of air, the fans are immediately speeded up.



"Auto Wheel Minus a Hub" Designed to Save Weight

A WIRE automobile wheel without the usual central shell that fits over the axle hub is one of the latest innovations in motordom. The wheel is said to weigh only eleven pounds. A similar wheel, with the usual hub, weighs eighteen.

Seven small metal rings, or eyelets, securing the inner spokes, and one large one, holding the outer spokes, take the place of the ordinary wheel hub. The small eyelets fit over the studs of the brake drums, where they bolt in place, tightening the inner spokes. When these seven bolts are drawn up tightly, a large cap on the outside of the wheel presses against the fixed hub of the car's axle. The wheel and the car axle hub are thus locked tightly together. In tests, the wheel is said to have shown remarkable strength.

Bird's-Eye View from Plane Reveals Buried City

ONE of the most paradoxical developments of modern science is found in the fact that aviation is proving itself a useful aid to archeology!

There are many archeological "clues," such as ancient roads, ditches, and the like, which are invisible to the passer-by on the ground, but which can be discovered from a height in the air because the aviator's bird's-eye view of the territory gives him an opportunity to observe conditions which form a scientifically unmistakable pattern.

A case in point was the recent discovery in this manner of the site of a Roman town somewhere in England. Leading British archeologists believe that beneath this site they will be able to unearth a complete city of Caesar's time, and they hope that, when excavations actually begin, they will find streets, houses, temples, arenas, and other treasures.

The scientists now preparing exploration plans which will bring this latest great archeological find to light decline to reveal the exact location of the mysterious city of antiquity until their arrangements have been completed. Meanwhile, unsuspecting persons are walking daily over this rich historic treasure-trove.

Inflates Soft Tire with Air from the "Spare"

A SPARE tire becomes a service station that travels along with you to supply free air for soft tires, through the use of a new "tire balancer," devised by Tom LeNay, of Los Angeles, Calif. The device is extremely simple. It consists of a twelve-foot rubber hose with a cap at each end. These caps fit over the valves of two tires, opening them so the air can flow from the tire with higher pressure to the one with lower. In this way, also, the four tires of a car can be equalized in pressure to maintain the highest efficiency of four-wheel brakes, now standard equipment on all new cars.

When the hose is connected with a soft tire and the hard spare tire, it allows air from the spare to pump up the flat tire so it can be driven to a service station for complete air service, or filled more easily with a hand pump, if a motor-driven pump is not available.

Oregon Village Sees Its First Automobile

ALTHOUGH more than twenty million pleasure automobiles were on the roads of the United States last year, the village of Agness, Ore., had never seen one until a roadster was sent there the other day. This community, on the Rogue River in the southwestern part of the state, contains only a handful of people and uses the river as its main highway. Grown children there had never seen a motor car of any sort. Then a dealer sent one of his cars up the river to give the village folk the thrill of their first auto ride.

To ship the automobile, he removed the rear wheels and roped the machine in the bow of a twenty-six-foot motor boat. The swift current of the mountain stream made the passage a risky undertaking, but it was completed without accident.

Every Little Dial Has a Meaning

WITH a dashboard containing as many instruments as are carried by a trans-Atlantic airplane, a small runabout made its appearance at Southport, England, recently. The woman motorist who drives the car has the assistance—or hindrance!—of thirty dials, clocks, and buttons, not to mention a strange assortment of mirrors, and other "gadgets."

The owner claims to be the world's champion buyer of auto accessories, and asserts that she can still pilot the car in spite of them!

She likes to know how the wheels are going 'round. But the question is, can she look at the right dial at the right time?

Colored Telephone Poles to Liven Landscape

BRIGHTENING up the landscape with colored telephone poles is a suggestion recently made before engineers attending a telephone association conference in Chicago. One expert reported that his company had perfected a new wood preservative which triples the life of the poles and can be made in a variety of colors. Telephone poles, he said, could be colored to harmonize with the landscape or to brighten barren spots.

Doctor Makes 7,000-Mile Call by Radio

A DOCTOR, 7,000 miles from a patient, diagnosed the case over the radio recently. A woman suffering from a dangerous malady in Buenos Aires, Argentina, was put in communication with a specialist in Berlin, Germany, over a test short-wave apparatus. After a conversation lasting twenty minutes, during which each could hear the other perfectly, the doctor was able to diagnose the case and to cable the prescription.

During the same week, a lock expert, in Idaho, was called on the telephone by an employee of an office in Oregon who had lost the combination to a large safe. The employee placed the telephone receiver close to the door of the safe and the distant expert, listening to the almost imperceptible sounds of falling tumblers in the safe door, directed her movements. In less than five minutes the door was open.

Tin Can Filling Station for Cigarette Lighters

FROM an empty tin can, you can make a filling station for vest pocket cigarette lighters by screwing on a newly devised combination metal tube, cap, and rubber bulb in place of the regular cap on the can.

The can holds sufficient gasoline to fill many lighters and, the makers say, forms a handy and economical means of keeping a vest pocket lighter replenished. The bulb is designed to have a capacity just sufficient for the ordinary lighter. Thus one squeeze fills the tank to the top without making it overflow.

Colds Blamed on Lack of Proteins in Diet

FREDERICK HOELZEL, of the University of Chicago, announces a theory, backed up by experiment, that susceptibility to colds is largely a matter of diet. Persons who eat too much sugar and starch, as most people do, and vegetarians and others who live on a low-protein diet, are far more likely to "take cold," he says, than those whose food is high in protein content. This tallies with reports of Arctic explorers that colds are unknown among the Eskimos whose diet consists entirely of meat.

The explanation of the Hoelzel theory is believed to lie in some undetermined relation between the amount of fluid in the body tissues and their sensitiveness. Starches and sugar tend to store up water in the tissues. When this intake of water is lowered the sensitiveness of the tissues is also lessened, so that a cool breeze or exposure to dampness does not so readily affect the system. This theory would account for the fact that fat persons, as a rule, are more susceptible to colds than thin ones.

Tin Foil Amazingly Thin

THE tin foil wrapped around chocolate, tobacco, or cigarettes is thick compared to the foil used in radio condensers, which measures 4,350 sheets to the inch!

The thinnest foil provides 14,500 square inches from one pound of metal. Tin and lead foil are said to have been invented by the Chinese centuries ago, by hammering bars of metal. Today they are made by automatic machinery.

Did Man's Legs Develop Before His Head?

AN EXHAUSTIVE study recently completed by Dr. Wilhelm Gieseler, of the University of Munich, Germany, tends to show that the pedal extremities of man's remotest ancestor developed into human legs sooner than his skull evolved into a human head.

The two most-disputed examples of human or near-human remains so far discovered—the bones of the Pithecanthropus or ape-man of Java and the Broken-Hill Man of South Africa—are so primitive, especially the skulls, that many anatomists deny them human rank

But Dr. Gieseler is of the firm opinion that the Pithecanthropus was decidedly human. This conviction he bases upon the fact that his eye sockets are manlike rather than apelike, although he admits that the skull is low.

And the thigh bones of both Pithecanthropus and Broken-Hill Man, according to D. Gieseler, tell a still more eloquent story. These bones, he says, are entirely unlike those of apes, but closely resemble those of modern man. This leaves the question up in the air, for, while Dr. Gieseler contends that his findings show that man climbed the evolutionary ladder literally feet first, scientists of the opposite school declare that the disputed thigh bones may not belong to the "low brow" skulls at all.

Stations Identified by This Radio Dial

THE latest radio dial is designed to flash the identification letters of each broadcasting station when its wave length is tuned in. Contact points are fitted in the dial at positions where the various stations are tuned in perfectly. Thereafter, each time one of the contacts is made a light flashes at the top of the dial and the letters of the station appear behind a lighted window. If wave lengths are changed, the contacts may be shifted.

Tiny Dynamo Operates New Batteryless Flashlight

A TWIST of the wrist supplies power for a new flashlight. Turning the handle winds a spring that operates a tiny dynamo and produces current for a two-and-a-half-volt light.

This Lilliputian electric light plant is said to furnish light as long as the spring is kept wound. One complete winding is said to supply light for two and a half minutes. While slightly larger than the ordinary flashlight, the invention weighs only two and three quarters pounds.

Experiments with flashlights without batteries were made by the United States Army some time ago and reported in POPULAR SCIENCE MONTHLY. At the time, the Army was considering discarding batteries entirely.

New Sugar Discovered in Dahlia Juice

A NEW sugar has been discovered in the juice of dahlia tubers by the U. S. Bureau of Standards, it was announced the other day.

In experiments to find out the structure of inulin, a starchlike substance found in dahlia juice, the sugar was discovered. Approximately ninety-two percent of the juice was resolved into the already known sugar, called levulose or fructose, but the remaining eight percent was a mystery. In further tests, the strange substance was reduced to crystalline form.

Construction of new radio dial. By means of contact points, the broadcasting station's call letters are flashed in the window when station is tuned in.

Oceans on Frozen Planet May Be Liquid Air

THE sunward side of Mercury, nearest the sun of all planets in our solar system, may reach a temperature of nearly 800 degrees Fahrenheit, a heat sufficient to melt lead, zinc, or tin and to keep all water on the planet's surface permanently in gas form, like the air on earth, according to Dr. William F. Meyer, of the University of California.

If Mercury were inhabited, liquid water to the population would be a rarity, obtainable only by means of complicated apparatus, as is liquid air on earth.

On the other hand, says Dr. Meyer, the outermost planets of the solar system suffer from equally extreme cold. Uranus, next to the last on our system's outer rim, probably experiences an average temperature of about 300 degrees F. below zero! This is close to the temperature of liquid air. If Uranus has an ocean, the scientist assumes that it must consist of that material. Volcanos on Uranus might spout icewater, melted from frozen rocks, as earthly lava consists of melted earth rocks.

"Rheumatics" a Real Storm Warning

ELDERLY people who say they can feel the approach of a storm or bad weather because their rheumatic pains increase, have been laughed at a good deal by the younger generation, but now physicians declare the oldsters are right.

At a recent convention of the Central Society for Clinical Research, in Chicago, a trio of distinguished doctors announced that observations over a number of years had shown that there exists, indeed, a close relation between storms, rain, and rheumatism. In ninety percent of the cases under observation, the patients were affected adversely by the approach of unfavorable weather.

Holder for Pipe Cleaners

THE smoker is provided with a new accessory in a holder for pipe cleaners which enables him to keep them within arm's reach on a table and prevents them from becoming dirty or bent out of shape. To lend attractiveness, designs are painted on the sides of the holders.

In this novel decorative holder, pipe cleaners are kept always handy and in good condition.

Lizard Hypnotized!

A CURIOUS animal of the Southwest, the blue-bellied lizard, has been proved susceptible to hypnotism. Edwin D. McKee, of the educational staff of the Grand Canyon National Park, has discovered that by keeping his eyes focused on those of the lizard as he approaches the elusive animal, it will remain tense and still and can be pinned to the ground with a quick dart of the hand.

Women Drivers Can Signal Now—No Excuse!

PROTECTION for the dress sleeves and arms of women motorists, when they have to signal stops and turns on a rainy day, is afforded by a gauntlet of rubberized fabric just devised.

The guantlet slips on the left arm, reaching above the elbow. It buckles snugly about the wrist to keep raindrops from running down the arm. When not in use, the fabric can be folded into a tight roll that occupies little space.

If Brain Size Counted, the Whale Would Be Smart

NEW substantiation of the theory that intelligence does not depend on the apparent size or weight of the brain, but rather upon its convolutions, was offered recently by a German scientist who, after years of investigation, announced that the whale, never distinguished for its brain power, possesses the largest brain of any mammal.

The record for brain-weight was established by a whale boasting some 247 ounces of gray matter! If brain volume had any influence on intelligence, it is apparent what an intellectual giant the whale would be when it is considered that the average brain of man seldom exceeds fifty ounces in weight!

Novel Lamp Cord Holds Cigarette Lighter

AN ELECTRIC lamp cord suspending a heating element from which the smoker can light his cigar or cigarette is the latest novelty for the living room. The lighter comes in a variety of colors to match the twisted silk-covered wire cord and so has the appearance of a tassel at the end of the cord. Pressing a button turns on the electric current for the heating element. Another switch, located higher on the cord, governs the lighting of the lamp.

The device is installed by simply unscrewing the electric light bulb, screwing in a special socket, and replacing the bulb.

A New Kind of Mosquito! This Makes 141

ANYONE who, in sultry summer nights, has had his patience tried by a twenty-five-minute hunt for a mosquito, will admire the persistence of C. H. Bath, sanitary inspector at the Panama Canal, who has captured a new species of this pestiferous family that had eluded experts during a chase lasting twenty-five years!

The reason for the unending hunt of the sleep disturbers by United States health officials is the fact that some of them are breeders of malaria. The new capture, however, did not prove to belong to a variety of this kind. It was added to a series of 140 species which have already been listed.

World's Greatest Gas Line

ACROSS rivers and through mountain canyons, from Amarillo, Texas, to Denver, Colorado, what is said to be the largest high-pressure gas line in the world was completed recently at the record rate of almost two miles a day. This 375-mile line, carrying natural gas from the Amarillo fields to consumers in Denver and Pueblo, Colo., was in operation just 193 days after work was begun.

Decorative Metal Sawing

You Can Master the Use of Jeweler's Saw Blades While Making an Attractive Brass Teapot Stand

By EDWARD THATCHER, *Noted Teacher of Metal Work*

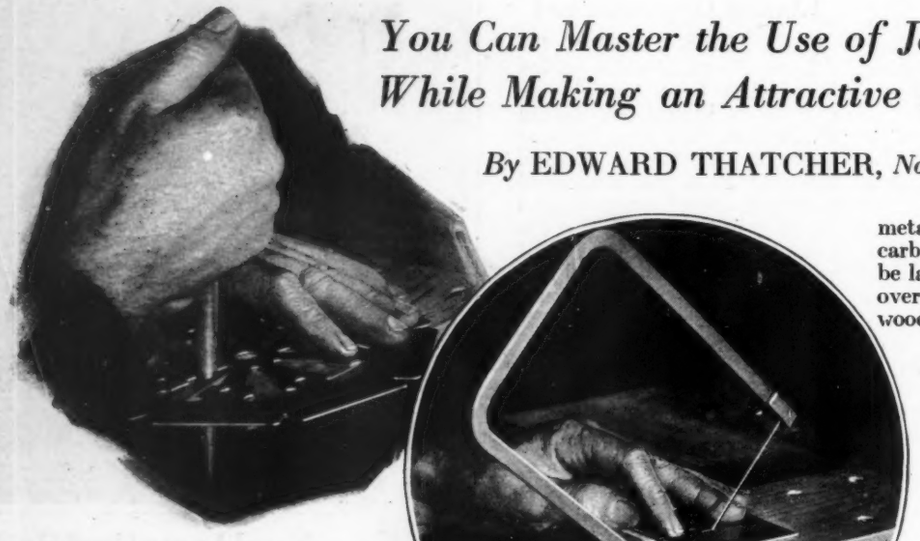


Fig. 2. The edges are smoothed with needle files and larger half-round and crossing files.

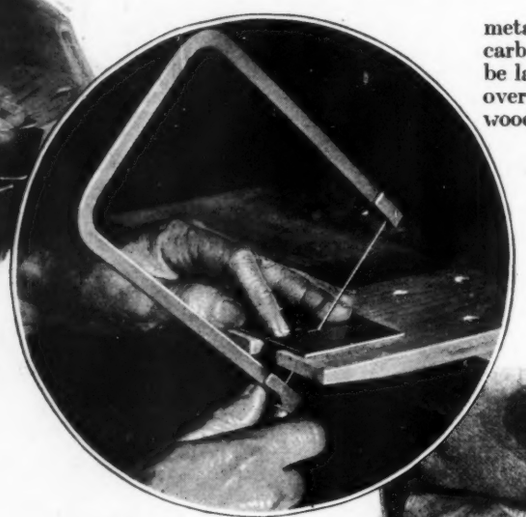


Fig. 1. The sawing is done on a wooden bench pin which has a triangular opening.

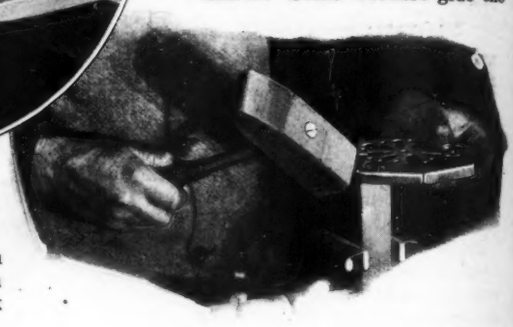


Fig. 3. The edges of the teapot stand are turned over with a malleton a clean-cut block of wood held in the vise.

SAWING is one of the most important operations to master in decorative metal work. While the heavier and larger pieces, such as hinges and hardware, may be cut out more readily with chisels as explained last month, the smaller pieces and intricate pierced openings in large pieces are usually cut with a jeweler's saw blade.

When the sawing is neatly done, little finishing is needed; it is sufficient to round over the cut edges neatly with files and emery cloth before the final polishing.

Those interested in model making or in radio construction will find a knowledge of sawing particularly useful. With proper saws an experienced worker can cut sheet metal up to ⅛ in. in thickness, but the beginner should start with thinner metal, say No. 18 gage.

You must have a good saw frame, either of the jeweler's or the coping saw type. If a coping saw frame is to be used, it should have two viselike clamps to hold jeweler's saw blades, which have straight ends. Ordinary coping saw blades will not, of course, do for metal. Be sure to get the best saw blades you can and do not worry if you break a number of them while learning to saw. Buy a dozen or two at the beginning; later on you can save money by buying them by the gross.

You will also need a bench pin or sawing board (Fig. 1). Dimensioned drawings for two types of bench pins were given in a previous article of this series (December, 1927, issue, page 80). In its simplest form it is a piece of hard poplar, maple, beech, or birch, ½ by 4 by 8 in., screwed to the top of the bench so as to project over the edge 4½ in. The wedge-shaped slot in the projecting end is 2 in. deep and ¾ in. wide at the open end. Attach it to the bench with flathead screws in countersunk holes.

Before you start sawing, be sure that the sheet metal is perfectly flat and also bright and clean. Scrubbing it with powdered pumice stone and water usually will put it in good shape and give it a slightly roughened surface to receive the marks of the carbon paper used for transferring a design to it.

Draw the design on stiff drawing paper, full size. Place a piece of new carbon paper face down on the metal, lay the drawing on this, and trace over the design to transfer it to the metal. Large thumb tacks may be used to fasten the metal to a drawing board; then the carbon and drawing papers, which must be larger than the metal, can be secured over it with other tacks driven into the wood. The carbon lines left on the metal would become blurred in handling, so go over them with a steel scribing point and scratch them in distinctly.

Sometimes the surface of the metal is painted with Chinese white water color, which comes in tubes, to make a good surface for receiving the carbon paper marks. Some workers glue the design directly on the metal with shellac, but I have never liked this method.

When a hammered surface is desired on the work, make the hammer marks on the metal before sawing.

If you have done no sawing, try some experimental cuts in a piece of flat No. 18 gage copper. A No. 4 blade will be satisfactory for this. Generally speaking, the thinner the metal, the finer the teeth of the saw should be. Jeweler's saw blades are numbered from Nos. 8/0 to 12, the last being very coarse. You will have to learn by experience the best blade to use for each job.

Be sure that the blade is set in the frame with the teeth pointing down toward the handle. The blade should be held so taut that it will sound like a banjo string when picked.

Hold the metal firmly down on the bench pin with the fingers of the left hand as in Fig. 1. Do not press the saw against the metal with much force; use only sufficient pressure to make the blade cut easily. Beginners are likely to press too hard with the result that the blade binds and breaks or runs off the line.

Usually it is better to tilt the frame slightly forward and down toward the work except when sawing around sharp curves or turning a sharp angle. At such times the saw (*Continued on page 126*)

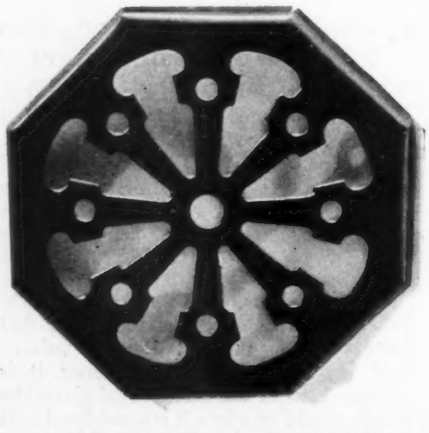
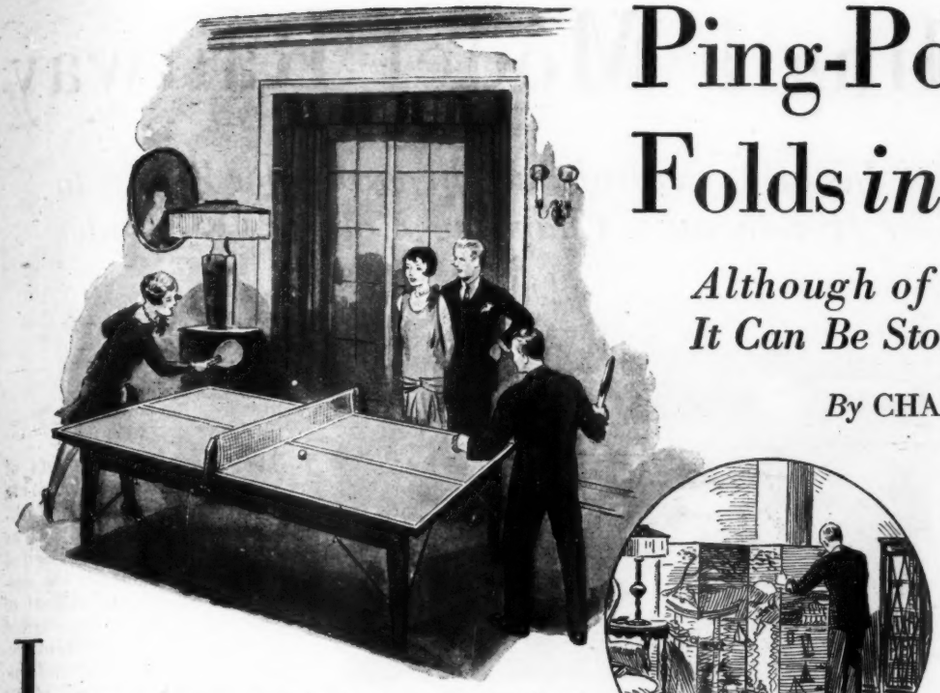


Fig. 4. Teapot stand made by Mr. Thatcher to illustrate the principles of sawing thin metal.

Ping-Pong Table Folds *into* Screen

Although of Tournament Size, It Can Be Stored in Small Space

By CHARLES A. KING



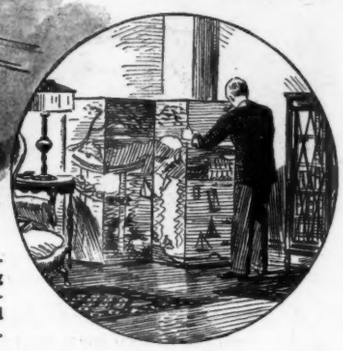


Fig. 1. This substantial ping-pong table can be transformed, legs and all, into a screen.

IN THE present popular revival of interest in ping-pong, many of those who have fallen under the spell of its furious fun have asked themselves the question: "How can I build myself a good, firm, large table which will not be cumbersome or unsightly when folded up?"

The latest answer to this question is the table illustrated in Fig. 1. It becomes, when folded up, a four-leaf screen. It can be transformed from a table into a screen and back again by one person. Although all the parts of the table are contained within the screen, there is nothing bulky or unsightly about it when it is set up in a corner of the room where only the face side of it can be seen. Either the dark green playing surface can be left exposed as the face of the screen, or a decorative covering of figured chintz or other fabric can be fastened with tape or thumb tacks to the four standing leaves.

It is true, of course, that a large dining room table may be turned into a ping-pong board, but it is usually too small for a real game. The standard size for a home ping-pong table is 4 by 8 ft.; the tournament table is always 5 by 9 ft. and allows a much better game to be played.

If a dining room table or other large, substantial table is available, the problem of making a ping-pong table is obviously much simplified. It is necessary to make only the folding top, which can be stood up out of the way to serve as a screen when not in use. In addition, two pieces of ⅞ in. thick board 9 ft. long will be needed to place on the table—or, if necessary, on two small tables—for supporting the folding game board.

If you wish to complete the table, you can, of course, provide detachable legs very easily and stand them away in a cupboard when the table is not in use. It is better, however, to go to the extra work required to make the legs self-contained as illustrated. Then they can be folded into the back or underside of the table top as shown in Fig. 2. The long rails, which come apart in the middle, are placed in the back recesses of the middle sections. All are held in place by springs.

The playing board may be made of ¾-in. plywood, which is often used in making commercial tables, but this gives an unwieldy top unless a permanent table is desired. Instead, the top of our table is made of ¼- or 5/16-in. plywood reinforced by ⅞ by 2 in. strips around the edges and across the middle. The use of pressed wood will still further decrease both weight and expense. It is a light, strong, stiff artificial board of warm brown color; its close grained, smooth surfaced texture make it peculiarly suitable for this purpose. However, almost any of the various pulp fiber boards on the market will be satisfactory and will cost and weigh less than plywood.

In making the board, first cut the four sections 27 by 60 in. See that each corner is perfectly square. If the pieces are cut from the nearest stock size, 32 in. by 6 ft., there will be considerable waste, which may be reduced if pieces 32 in. by 10 ft. can be obtained. If the latter are cut exactly in the center with a thin, fine saw, the only waste will be a 5-in. strip from the edge of each.

From seven pieces ⅞ by 2 in. by 10 ft. of whitewood or other semihardwood, miter the reinforcements around the underside of each section. Plane their inside edges carefully, glue each piece as shown in Fig. 3, turn the board over, and drive 1-in. No. 15 brads slantingly through the top, setting them just below the surface. Before fastening (*Continued on page 111*)

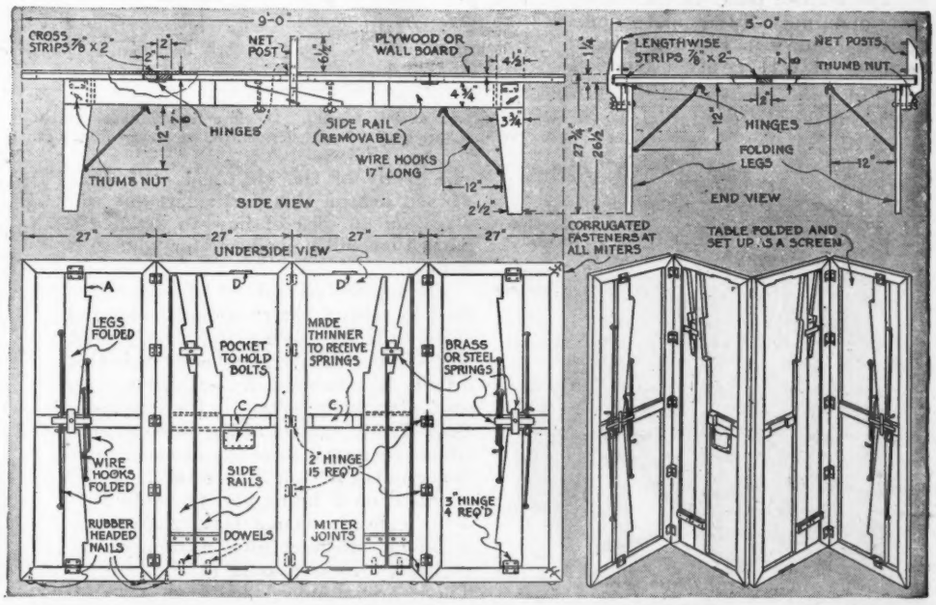


Fig. 2. Side and end views of the table; the underside of the top with the legs folded and the side rails stored away; and a drawing to show the rear of the screen, although ordinarily this side of it will be hidden.

Controlling a Model Railway

A Simple Way to Install a Central Switchboard from Which to Govern All Train Movements—Changing Voltage on Grades

By
FREDERICK D. RYDER, JR.

Fig. 1. Apron-type control panel used by James A. Baker, of Darien, Conn., for operating his exceptionally well-arranged model railway.

JUST as it is necessary to plan the track layout of a model electric railway before you start building, so it is wise to make a preliminary study of the type of electrical control system you wish to install.

The ideal control system would be one that would permit you to sit in front of the control panel and perform all the operations of running the trains without leaving that position. And that degree of control can be obtained easily with the equipment now available.

Automatic reversing electric locomotives, of course, are needed, as well as electrically operated switches. Your problem is, therefore, one of arranging the control panel so as to make it convenient to handle and to install the wiring.

The location, size, and construction of the panel is governed by the size of the system and the position in which the control panel must be located. If the track layout is placed on a shelf or bench, the panel can be installed most simply by fastening it edgewise to the bench like an apron. A piece of plywood can be used.

The control panel of the elaborate and unusually complete model railway shown in Fig. 1 is a good example of this type of construction.

For track layouts placed on the floor, a simple design for a control panel is shown in Fig. 3. Cheap yellow pine siding is used to make it, with a piece of plywood for the surface where the switches and control buttons are mounted. As shown in Fig. 2 the top is hinged at the bottom edge to facilitate wiring.

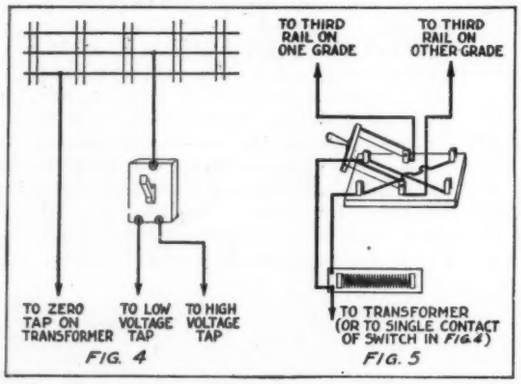

TO ZERO TAP ON TRANSFORMER
TO LOW VOLTAGE TAP
TO HIGH VOLTAGE TAP
FIG. 4
TO THIRD RAIL ON ONE GRADE
TO THIRD RAIL ON OTHER GRADE
TO TRANSFORMER (OR TO SINGLE CONTACT OF SWITCH IN FIG.4)
FIG. 5

Fig. 4 (at left above). Quick acting voltage switch. Fig. 5 (at right). Switch for controlling power on grades.

A study of the electrical control as worked out on this particular unit will give you an idea of how to arrange a panel that will be suitable for your own system.

The top and second row of buttons are used to control the electrically operated switches in an interlocking arrangement that will be explained farther along in this article. The buttons in the third row are connected to the sidings in the terminals. Push-button control of the sidings is desirable because it forces you to keep your finger on the button while a train is being operated on a siding and prevents accidents caused when a train rushes into a siding, crashing into a bumper or, perhaps, wrecking part of the station. These are standard half-inch doorbell push buttons obtainable in any electrical supply store.

The fourth row consists of small toggle switches such as are sold to radio set builders. Push-pull switches would do just as well as the toggle type. Each of these switches controls the current flow to a different part of the main line so that the current can be cut off from different sections of the main line and one train stopped at these points without stopping any other trains that may happen to be running on other parts of the track. This method of sectional control was described in detail in articles in the December, 1925, issue of POPULAR SCIENCE MONTHLY, page 72, and the January, 1926, issue, page 80.

The two knobs are rheostats of the heavy-duty type. They should be capable of carrying at least 2½ amperes of current. One controls the current to all sections of the terminal, and the other controls the current to all parts of the main line except the grades. This makes it possible to control a locomotive engaged in switching operations in the terminal without affecting trains running on the main line.

A double-pole double-throw knife switch between the rheostat knobs controls the current to the grades. Whatever goes up eventually must come down again, so if you have an up-grade in your track layout there must also be a down-grade to get back to the original level. Considerably more voltage is needed to drive the locomotives up the grade than is required on the level, and on the down-grade the voltage must be reduced to prevent the (*Continued on page 120*)

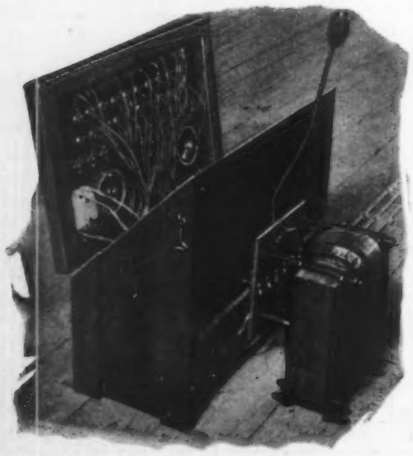


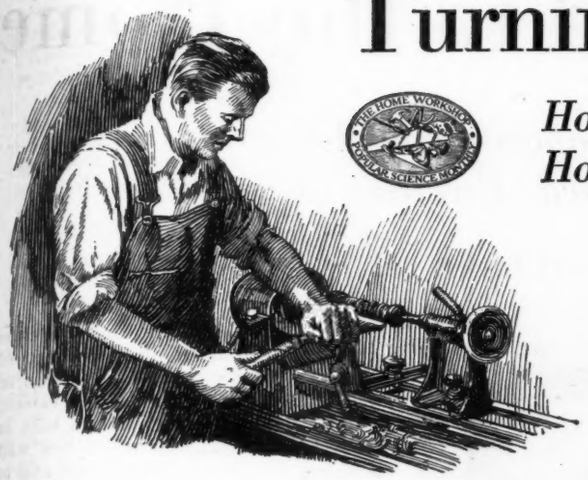
Fig. 2. Desk type of control panel as seen from rear, with panel raised to show connections.

Fig. 3. Front of the panel shown in Fig. 2. It gives complete control of all train operations.

Turning Rings of Wood

How to Make Napkin, Tie, and Towel Holders, and Round Picture Frames

By Herman Hjorth



A fascinating field for experiment is offered the amateur craftsman in turning rings.

NOW that motorized home workshop machines and small wood turning lathes are in use in so many homes and wood turning is becoming so popular a hobby, there is a demand for designs and projects that are a step in advance of candlesticks and other elementary articles with which beginners are at first content.

Readers have indicated that they are eager to try something requiring more skill. A fascinating project is therefore suggested—the turning of a solid ring of wood. This requires no additional tools or equipment. It represents an advance in the line of faceplate work discussed in the October and November, 1928, issues of Popular Science Monthly.

An example of ring turning is the napkin holder illustrated in Figs. 1 and 2. This is turned partly between centers and partly on the faceplate.

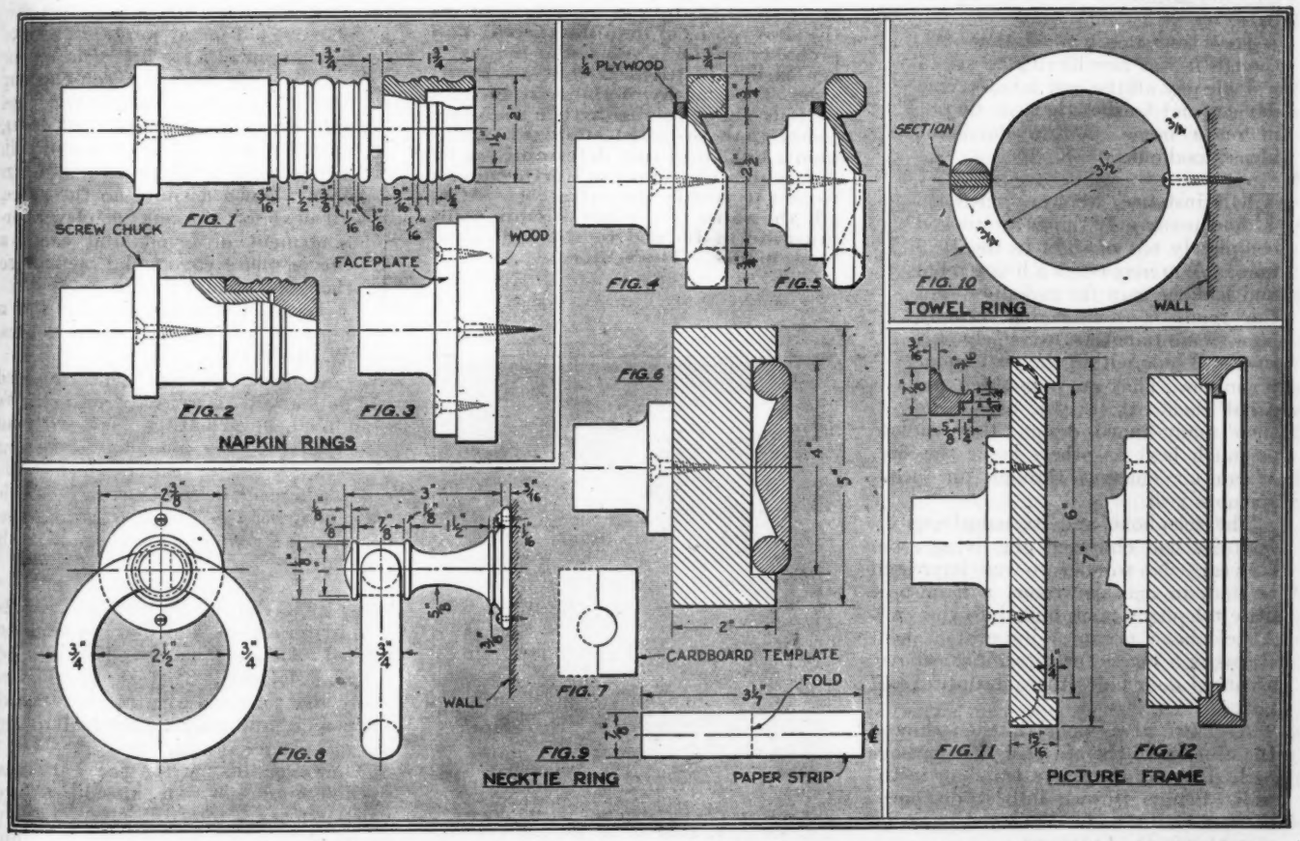
If it is desired to turn two napkin rings, cut a piece of wood at least ¼ in. thicker and wider than the finished outside diameter of the ring and about 2 in. longer than the combined length of two rings. For two rings of the dimensions indicated in Fig. 1, the rough stock should be 2¼ by 2¼ by 6 in.

Square one end of the piece carefully with the sides, an operation which may be done conveniently by sawing the stock in a miter box. Locate the center by drawing diagonals and bore a 3/16-in. hole about ½ in. deep with a gimlet or twist bit. Fasten the piece to a screw chuck, which is simply a small faceplate with a single heavy screw in the center.

If a screw chuck is not a part of the lathe equipment, an ordinary faceplate may be used. Screw a piece of wood to the faceplate and turn a circular disk as explained in the October, 1928, issue, page 112. Mark the center on the disk while it is revolving in the lathe and bore a 3/16-in. hole, countersinking it on the side which is against the faceplate. Insert a heavy flat-head screw of the proper length (depending upon the thickness of the disk) and fasten the piece to be turned firmly to the disk as in Fig. 3.

The dead center is now run against the free end of the 2¼-by-2¼-by-6-in. piece, which is rounded off and smoothed in the usual manner. The napkin rings are then laid out, turned, and sanded as explained in previous articles.

When the outside shape of the rings has been formed, the dead center is moved out of the way and the tool rest placed close to the end of the piece and at right angles to the lathe bed. Mark the diameter of the 1½-in. hole with a pair of dividers (use the second method described on page 132 of the Oct., 1928, issue) and start the boring of the hole with a very sharp round-nose chisel. Begin in the center and gradually work out towards the (*Continued on page 116*)



Any wood turner who masters these four simple projects will be able to do a large variety of similar work. A close-grained wood such as birch, maple, mahogany, or walnut should be used, or, for more ornamental effects, a combination of contrasting woods glued in layers.

Luxuries to Add to the Home

Magical New Comforts and Labor-Saving Inventions to Help Bring the Old-Fashioned Dwelling Up-to-Date

By MILTON G. STURGISS

"HELEN, I saw a wonderful house today." I lit my pipe, hitched up a chair to a comfortable place near the fire, and started on a "selling talk" I had prepared for my wife.

"Went out to look at that 'model house' in Meadowville today. Talk about your 1929 styles! I didn't realize how out-of-date our place is getting until I saw the new one. It's the last word—even to shoe-shining cabinets that fold in the wall and colored tile bathrooms!"

"I suppose you want to go right out and buy it," observed Helen.

"I'd like to," I admitted.

"So would I. But you know mighty well we can't afford it. What's the matter with making our own place over, a little at a time? Let's make our own synthetic 1929 home."

That was the start of the argument. The finish was that the next Saturday we made a tour of the manufacturers' show windows to see what ways there were to bring our old-fashioned dwelling up-to-date.

That tour was a revelation. Although it was bewildering to see in a single day all the new labor-saving devices and finishes that can be put in one's home, certain dominant ideas stood out.

FOR instance, we were surprised how many ugly things are tucked completely out of sight in the 1929 home. You may enter a living room and look in vain for radiators—yet the room is comfortably heated. New steam radiators, extremely narrow, will hide within the wall under a window. They are only three and a half inches thick; yet, because of their many-finned design, they radiate as much heat as others twice the size. Warm air emerges through an inconspicuous grill.

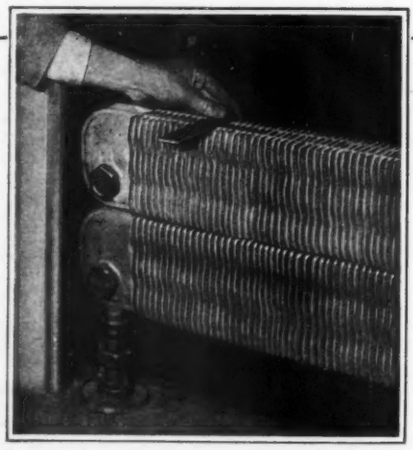
The telephone and its monstrous directories had cluttered our living room for years. No wonder we were impressed to find, in one showroom, a handsome little telephone nook built into the wall. A telephone occupies its center shelf. Below is a recess for directories; above, a carved door hides the unbeautiful bell box.

A glance at a model kitchen showed the absence of the old unsightly garbage pail. Instead, there is a trapdoor in the wall. Scraps thrown into it disappear down a chute, to be destroyed in an incinerator in the basement.

Bulky objects have a way of vanishing in 1929, we learned. A white enameled panel in a tiled bathroom wall folded out when I pulled a small handle, and revealed itself as a shoe-shining cabinet. A surprising built-in cupboard only an inch or two thick, on a kitchen wall, revealed a folding utility table and an ironing board when Helen opened the door.

For casement windows—a "ventilating" pane of bulging glass, with shutters beneath.

"HOW can I make my house more comfortable and more convenient?" The author answers this question, asked by thousands of American home owners, with the story of a trip which he and his wife made to the showrooms of manufacturers. You probably will be as amazed as he was at the variety of luxuries that are available. True, many of the conveniences he tells about in this article are more costly than so-called standard equipment, but you must determine, as he did, which of them are worth enough to you to justify the extra cost. After all, the value of a piece of equipment must lie in its use to the individual householder.—The Editor.



A space-saving radiator, only three and a half inches thick, hides within the wall beneath a window ledge. Its many-finned design is claimed to afford abundant radiating surface.

WE WERE delighted with many other built-in improvements. A recess in the wall, lined with asbestos-coated steel, offers a handy receptacle for the electric iron when not in use. A ventilated aluminum door allows the iron to cool quickly and safely. One ingenious invention is a cabinet set into the kitchen door, used for receiving delivered packages when you are not at home. The grocery boy inserts his bundles through an outer door; returning home, you unlatch the inner one and remove the packages, which, meanwhile, have been protected from rain and stray animals.

One of Helen's pet dislikes is to clean out the ashes in an open fireplace. That messy job takes a lot of the fun out of a log fire. But on our tour we ran across a self-cleaning hearth. To empty ashes you need only grasp an inconspicuous lever, unlock it with half a turn, and pull. A trapdoor beneath the hearth swings open. Down a chute go the ashes. Meanwhile, through a clever arrangement of levers and cams, a curved plate covers the opening so that dust cannot fly up.

To us, the modern home was a museum of built-in conveniences. What else?

A pageant of color! Spectral-hued pots and pans are only a start. We wouldn't believe, until we saw with our own eyes, that we could buy a heating boiler in sky blue or scarlet. In the bathroom, where staid white has so long held sway, many-hued tiles, alternating sometimes with striking black, are now newly popular.

AS VARIED as their colors are the materials in which these tiles are offered. One of the novelties is a so-called Belgian tile that is flexible, and can be bent around corners. It is coated upon zinc, and may be applied to any smooth plastered wall.

A modern luxury for the bath that excited our envy was a glassed-in shower compartment trimmed in gleaming chromium plate—built up from the bathtub's rim nearly to the ceiling. Splash away to

your heart's content, and not a drop can spatter on the floor. A grille at the top of the glass door provides ventilation.

Built into the wall, a new bathroom heater contains three objects that look like electric light bulbs. To my surprise, when I pressed a switch, a pervading warm glow issued. The bulbs are especially designed for heating, although they contain filaments like ordinary lamps.

HAVING examined the new "fixtures" of the modern house, we turned next to interior wall finishes.

Once you could take it for granted that living room walls would be covered with wall paper. Now they are paneled, in fascinating new materials. Or, if you prefer, they are covered with a textured, stuccolike finish applied with a brush and molded and colored to suit any style of architecture.

For wood paneling, among the novelties, there is a new fireproof wood, chemically treated. It looks like ordinary wood, and retains its finish as well, yet its makers claim that it cannot burn. It is used for wainscoting, trim, flooring, doors, or molding.

Another paneling is a "woodless wood," made of Portland cement and asbestos. Only when you rap the panels, or beams of the same material, does a stonelike response betray the substitution.

A third is a grainless wood, made by shredding actual wood and then pressing it together again. Dense and tough, it is said to be proof against cracking and impervious to moisture.

Now, too, there is an amazing wall finish that transforms painted plaster walls and beams into wood. Even the grain of wood is imitated. The product is a thick liquid. A companion finish produces an effect of stone.

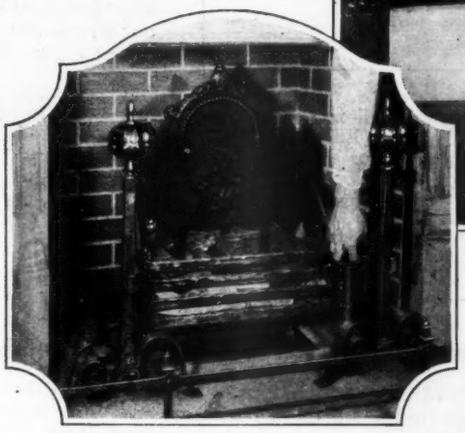
ALL the beauty of stone walls in Colonial, Spanish, or even modernistic style is possible through new "plastic paints," giving a variety of textured finishes. These are powders, which are mixed with cold water and applied with a brush to the wall or ceiling after any wall paper has been removed. Then they are molded to the desired texture by manipulating the surface with a brush, whisk broom, comb, sponge, wad of paper, or even the palm of your hand! They harden to a stonelike finish. Water or oil colors are used to tint them; should you tire of a water color after a few months, it can be removed with hot water and soap, and a new one applied. A glazed finish is a possible variation.

For those who still prefer the old styles, another novelty is "wall paper" of cloth! It is hung like wall paper; and if soiled, after months of wear, it may be wiped clean with a damp cloth.

Casement windows have lately come into vogue for modern interiors. But there is a temptation to keep them shut when a gale is raging outside, even if the air in the room is becoming unbearably stuffy. Now it is possible to admit the air, but keep out the blustering gale, by inserting one or two new "ventilating panes" of bulging glass instead of the standard flat ones. Openings in them let in more or less air, as desired, through control shutters. The hooded shape keeps rain out.

New windows, some in handsome steel sashes, swing inward for easy cleaning. An innovation in window screens is one that is wound on a roller like a shade.

A glass-inclosed shower bath cabinet is the latest luxury in the up-to-date home. Note the modern bathroom—floor and walls tiled.



Pull this inconspicuous lever, and a trapdoor in the hearth dumps the ashes down a chute to the cellar.

Helen and I soon discovered that we might make over even the exterior of our house in accordance with modern ideas. We were impressed by the new beauty of standard building materials. New stuccos, among them a waterproof, elastic material that will bend without cracking, have attractive textures and tints; and face bricks now offer a many-hued, colorful wall of purple and rose, red and chocolate brown hues.

THERE are almost as many different types of roofs as houses to put them on. Asbestos shingles, durable and fireproof, are offered for roofs and siding. They are applied directly over the old surface and provide a pleasing variety of color possibilities. Copper shingles are obtainable in strips that are light in weight and give a roof of exceptional permanence. An attractive French tile for roofing is made of concrete. An interesting novelty, where economy is paramount, is a "print roofing" made of asphalt-saturated rag felt, that comes in rolls. Applied directly on a new roof, or over old shingles, its fabric carries a shingle pattern.

A house that is warm in winter and cool in summer is possible through the use of one of many heat-insulating materials. One is a composition board manufactured from cane fiber, used under the plaster for inside walls and ceilings. It supplies insulation back of brick, wood, or stucco exteriors. In homes already built, it sheathes the walls of attic and basement. Plastic paint for wall interiors may be applied directly over it; or decorative panels may be created with gold bronze and stenciled Japan colors, applied with the aid of glue size and varnish.

Among other coal-savers are cork boards, quilts of felt or other substances used as lining in (*Continued on page 160*)

A corner of the 1929 kitchen. The photograph shows, left to right: Utility table that folds into wall; incinerator chute; electric sink with built-in dishwasher; wall thermometer; handy cabinet.

Popular Science MONTHLY

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Railroads, Airplanes, and Speed

RECENTLY published reports of the latest and largest locomotive in the world, built for the Northern Pacific Railroad, stress the fact that engine and tender are half the length of a city block, weigh a million pounds, can pull a loaded train two miles long on a level track, and consume twenty tons of coal and 14,400 gallons of water an hour. But nothing is said of its speed.

Indirectly that omission explains one reason why this country is being criss-crossed with air lines. Speed, especially in transportation and communication, is the great discovery of the age, and for more than two decades our railroads have made no progress toward greater speed.

Twenty-five years ago a man could board the Twentieth Century Limited in Chicago and be in New York just as quickly as he can today. In fact, the time now is two hours longer than it was when the run was made in eighteen hours. Other famous trains still run on time schedules established years ago.

And it isn't because a railroad train can't go faster. The Empire State Express, running between New York and Buffalo on the fastest schedule in this country averages only 48.7 miles an hour. Yet that same train covered a mile in 1893 at the rate of 113 miles an hour.

So long as our railroads are content to live in the past, resting on honors already won, the swift winged airplane will continue to prosper because it answers the modern demand for speed—and more speed. Nothing can stand still and survive.

John Early, Leper

WRITE down, among the decisive episodes of history, the strange story of John Early, leper. It is a story not only of a brilliant victory of medicine over the dreaded scourge of centuries, but of a dramatic battle to save a man from himself.

John Early, a North Carolina mountaineer, became notorious for his many escapes from leper colonies and for his armed resistance to confinement and medical treatment. One day about five years ago, the national capital was startled to learn that he had escaped from the National Leper Home at Carville, La., and had registered in a Washington hotel. Pursued, he armed himself with a rifle, hid in his mountain home, and for months resisted capture. But at last, in May, 1927, he gave himself up to Federal officers and was taken back to the leper home. There he submitted to treatment.

Now comes the announcement from the United States Public Health Service that John Early has recovered. His terrible disease has been arrested by a new method of treatment by injections of chaulmoogra oil. He is scarred, but free!

Thanks to heroes and martyrs of medical research, the tragic cry, "Unclean!" is passing from the earth. Its passing renews hope that remaining scourges, such as cancer, soon may be overcome.

The Double Duty of Science

BENJAMIN FRANKLIN once observed that while his attention was concentrated on attempting to eradicate one of his bad habits, another would creep in unaware. Every now and then the same thing happens to the human race as a whole.

While people's thoughts are occupied with the problem of crossing the ocean by air, the tragedy of the *Vestris* brings us to a shocked realization that much still has to be done before we can honestly say that crossing the oceans—even by ships—is absolutely safe.

And while the sinking of the *Vestris* may or may not have been preventable, the fact remains that such a catastrophe is a blow in the face to our vaunted scientific progress. As pointed out on page 30 of this issue, the business of science is to render safer our present modes of travel, as well as to perfect new ones!

War on the "Common Cold"

MAN'S most mysterious and most expensive ailment is what is foolishly called a "common cold." Two good hard common colds are the average annual lot of everyone in America. And a recent survey showed that colds are responsible for forty-seven percent of the time lost in industry.

Science has not yet located definitely either the cause or its cure. But like every disease about which medical knowledge is scarce, theories are plentiful. The demonstrated facts seem to be that colds are caused by germs; that these germs are most virulent in the early stages, and that colds are most prevalent at certain seasons of the year. Nothing more.

However, studies just begun at Johns Hopkins University may result in determining reasons and remedies for the cold, an achievement from which everyone of us would benefit. This would save hundreds of millions a year in wages and—more important, would reduce the number of deaths from pneumonia, diphtheria and other destructive diseases. Nature built the body machine. Science teaches us how to keep it well oiled—to keep it free from disease.

Marvels We Take for Granted

MORE than 20,000 electric signs flash on at dusk in New York City. The bulbs in these signs number more than a million. Still, nobody wonders whether they will function when the switch is thrown. Their reliability is taken for granted. Yet, it was only in 1888 that the first electric sign in the city caused a seven-day sensation. And eight years earlier, passengers on an Atlantic steamship sent the company a note of congratulation on the working of electric lights on board!

It is the uncertain that commands our attention. The biggest thing on earth is the ocean tide. The greatest power-plant in our heavens is the sun. They function like clockwork. We are sure of them. And we give them little thought. Similarly with inventions, and the products of man's ingenuity. We marvel awhile then turn to the next wonder. When their reliability becomes assured, we take them for granted.

They Are Saying—

"WATER power in the future will be inadequate to meet the demands for electrical power."—Thomas A. Edison.

"I felt infinitely more concerned for my safety in crossing Fifth Avenue, New York, than I ever felt in the Jungle."—Arthur Vernay, big game hunter.

"Our American women are in better physical condition than our men. Women do not wear too many clothes."—Dr. Ephraim R. Mulford, President of the Medical Society of New Jersey.

"Coal, which costs less than $3 a ton at the mine, should be turned into gas at the mine, furnishing the producer with $15 worth of by-products per ton."—Dr. Arthur D. Little, famous chemist.

Look for this mark on every Radiotron

E. F. McDONALD, Jr.
President, ZENITH RADIO CORPORATION, says:

"We determine the performance of all of our receiving sets by using RCA Radiotrons. That is because they materially enhance the reception of our instruments. We urge our dealers to recommend them for initial equipment and for replacement."

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If you wish your receiving set to give you the best results, renew all of your vacuum tubes with RCA Radiotrons once a year at least. It is better not to use new tubes with old ones.

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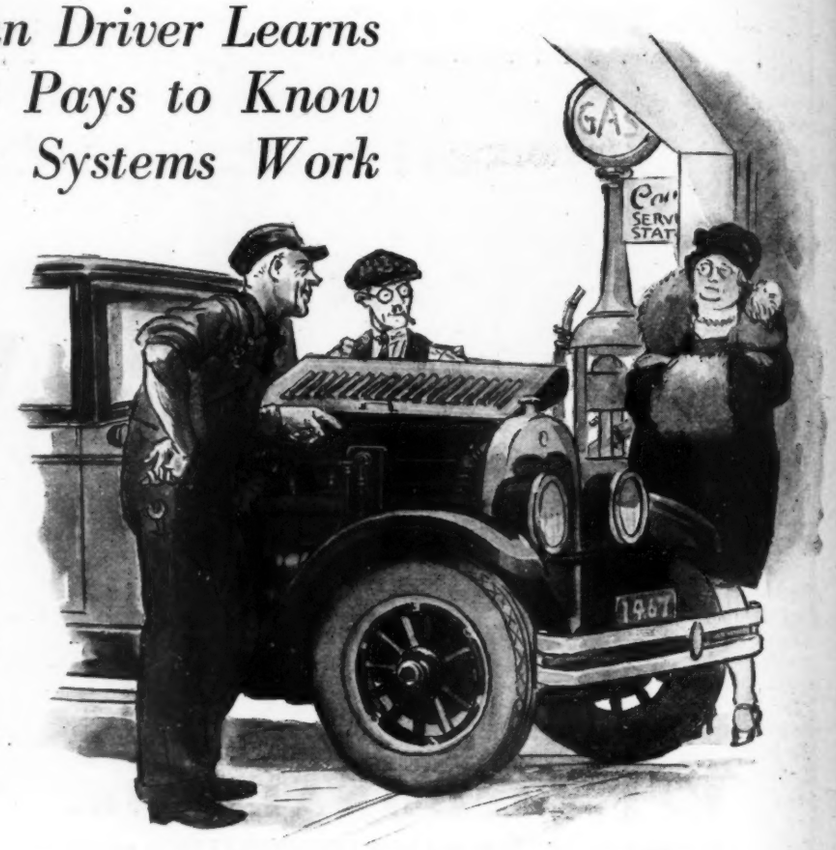
What Feeds Gas to Your Car?

A Haughty Woman Driver Learns from Gus Why It Pays to Know How Fuel Supply Systems Work

By MARTIN BUNN



"Primed the vacuum tank?" Gus grinned. "That, lady, is the oil filter. This car has no vacuum tank."

"YOU the mechanic here, my man?"

A harsh, feminine voice rattled Gus Wilson's eardrums and brought his head around with a jerk.

"Yes'm," he mildly replied to the bossy female whose car had coasted up behind the veteran auto mechanic.

"Well," she snapped, "I hope you're not as dumb as most auto mechanics. I know something about cars myself and I don't intend to be swindled. Can you fix this car or can't you?"

"What seems to be the matter?" Gus inquired, still mildly.

"It's your job to find that out," she replied pointedly.

Joe Clark, Gus Wilson's partner in the Model Garage, had strolled over to watch and the older man slyly winked at him as, without further remarks, he raised the hood of the car.

"Now don't try to tell me it's the vacuum tank," she warned Gus. "I took off the pipe and primed it with gasoline several times and that isn't the trouble."

"Primed the vacuum tank?" questioned Gus, puzzled.

"That's what I said," she snapped. "I took off that pipe right there." And she pointed to a round metal tank fastened to the side of the engine.

"I don't wonder that didn't do much good," Gus observed with a grin. "That tank, lady, is the oil filter. This car hasn't got any vacuum tank!"

"What!" she gasped, and her domineering attitude went down like a flat tire. "No vacuum tank? Why, the course I studied said that all cars had vacuum tanks."

"Not quite all," grinned Gus. "In Ford cars, both the old lizzies and the new ones, they stick the supply tank up high enough so the gas'll run downhill into the carburetor. It's called the gravity system. But there's at least three other ways of doing the job. Air pressure is one of 'em. Then there's a dinky little magnetic pump that draws juice from the battery to work it. And this boat and several other breeds use a new kind of a mechanical pump."

"WHY so many different systems?" the woman inquired interestedly. "I should think only one could be the best, so why use the others?"

"Differences of opinion is what makes horse trades, ma'am," Gus replied. "Each system has its good points and its bad. It looked for a while as though the vacuum tank would win out. Nearly all cars had 'em. But better roads and faster driving brought out a bad feature. When you're sailing up a long, steep mountain road, or burning up the road on the level, the vacuum tank falls down on the job. It depends on the vacuum in the manifold to work, and when the throttle is nearly wide open there isn't any vacuum.

"The pressure system gets around that trouble, but it costs more to install, and there's always a chance for a leak in the pressure lines. The gravity system, though, can't go wrong unless somebody repeals the law of gravity!"

"If it's so perfect, why doesn't every car have it?" the woman inquired.

"SOME designers," explained Gus, "don't like the idea of putting the gas tank in the cowl back of the dash, and that's about the only place in a modern car where it will be high enough to feed right on the hills. It works out all right in light cars with small gasoline tanks, but a big car needs a bigger tank that takes lots of room, and when it's full there's a lot of weight up in the air instead of down near the road where it ought to be."

"What's the matter with the other two systems you mentioned?" she asked.

"Well," Gus replied, "the electric pump goes dead if something happens to the electric wiring, and the new mechanical pumps haven't been on the market long enough to be sure about what they do after years of service."

"Which system would you rather have on your own car?" the woman inquired.

"Any one of 'em," said Gus, "so long as it was installed right and put where it could be repaired easily."

"BUT you'd want to be able to recognize it, wouldn't you?" she smiled.

"That *is* kind of necessary," admitted Gus. "And there's another thing about automobiles you ought to know. Don't jump at conclusions. You made up your mind that something was wrong with the gasoline feed and you were bound you'd find that kind of trouble."

"What is wrong, anyhow?"

"Oh, I fixed that while we were talking," Gus grinned. "The high tension wire had snapped off at the coil. Now I'll drain the crank case to get rid of the gasoline you poured into the oil filter, and put in fresh oil."

She cordially thanked Gus and drove off. Joe then spoke up.

"Good work, Gus. Know who that was? That's Hank Preeble's widow. He left her a big trucking business over in Tupperville. She's got a lot of repair work she could throw our way. It sure pays to treat 'em right."

"Sometimes it's a tough job, though," grunted Gus, "I certainly wanted to tell that dame to go jump in the lake!"

Medium Size Eveready Layerbilt "B" Battery No. 485. 3¼ inches thick. 45 volts.

The original Eveready Layerbilt "B" Battery No. 486. 4 7/16 inches thick. 45 volts.

EVEREADY LAYERBILTS

GIVE 25% TO 30% LONGER SERVICE, YET COST YOU ONLY A FEW CENTS MORE

IF YOU have been buying the Medium Size Eveready "B" Battery No. 772, at $2.75, add only 20 cents to what you have been paying, and get the Medium Size Eveready Layerbilt "B" Battery No. 485. For these few extra cents you get a genuine Eveready Layerbilt, made of flat cells. It will last 25% longer than the cylindrical cell battery of the same size.

If you have been using the cylindrical cell Heavy Duty Eveready "B" Battery No. 770, at $4, next time add just 25 cents to its price, and get the Eveready Layerbilt "B" Battery No. 486. This is the famous original Eveready Layerbilt, the longest lasting, most economical and convenient of all Eveready. It contains much more active materials than the cylindrical cell Eveready of the same size, and lasts 30% longer.

It is possible to pack more active materials inside an Eveready Layerbilt because it is built of *flat* cells. These pack together tightly, occupying all available space inside the battery case, and eliminating many soldered connections. The waste spaces between the cells of a cylindrical cell type of "B" battery are avoided. An Eveready Layerbilt is all battery. That is why it lasts so much longer. Next time you buy "B" batteries, get Eveready Layerbilts.

Layerbilt construction is a patented Eveready feature. Only Eveready makes Layerbilt batteries.

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TUESDAY NIGHT IS EVEREADY HOUR NIGHT —*East of the Rockies*, 9 P. M. Eastern Standard Time, through WEAF and associated N. B. C. stations. *On the Pacific Coast*, 8 P. M. Pacific Standard Time, through N. B. C. Pacific Coast network.

SEE AND HEAR THE NEW EVEREADY RADIO SETS

IS This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

The Month's Best Auto Ideas

Handy Kinks That May Save You Trouble or Get You Out of It—An Ingenious Opener for Garage Doors

Fig. 1. Incision in radiator, after the shell is removed, gives access to obstructing particles.

THE "neck of the bottle" in an automobile radiator is at the top of the cooling fins or tubes. Any foreign matter that floats around with the water always gets stuck at this point and the result is retarded circulation and a tendency for the motor to overheat.

Ordinary flushing will not remove serious obstructions. But you can get them out by the simple method shown in Fig. 1. Remove the radiator shell and with a sharp, strong knife make a curved incision. Then fold out the flap thus formed. Pick out the obstructions with a pointed instrument, push the flap back in place, and solder it. Radiators are made of thin sheet brass so this is easier than it looks.

A Tool Compartment Lock

A COMMON location for the tool compartment in the sedan or coach is under the front seat. Usually it is necessary to raise the front of the seat cushion and pull it forward in order to lift it out to get at the tools.

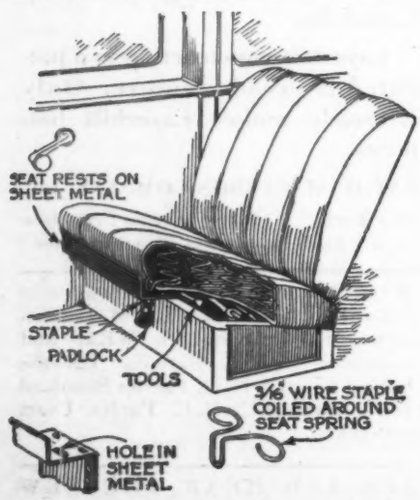


Fig. 2. By preventing lifting of the seat, this lock safeguards the contents of your tool compartment.

You can fit a lock, as shown in Fig. 2, that will prevent lifting the front edge of the seat cushion and thus prevent the theft or unauthorized use of your tools when the car is stored in a public garage.

Ten Dollars for an Idea!

G. Solomon, of Puerto Plata, Santo Domingo, wins this month's ten-dollar prize for his suggestion of a garage door opening device (Fig. 3). Each month Popular Science Monthly awards $10, in addition to regular space rates, for the best idea sent in for motorists. Other contributions used are paid for at the usual rates.

Both Doors Open At Once

FIGURE 3 shows a novel fitting for any double garage doors. It is designed so that when you open or shut the door at the left in the illustration, the other door will open or shut automatically. The material you need consists of a board of sufficient length, three bolts, a strong iron hinge, and wood screws.

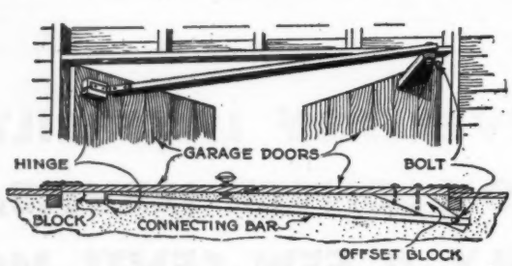


Fig. 3. Side and top views of the ingenious device for making double doors open at the same time.

As you open the door at the left, a connecting bar, pulled along with it, opens the door at the right by pulling on the end of the offset block. In closing, the thrust of the connecting bar closes the door at the right.

Blowing Starts Siphon

AN INGENIOUS way to siphon gas from the tank of your car is illustrated in Fig. 4. Insert one end of a rubber tube deep into the gas tank; the other into a container. Then, wrapping your fingers around the tube where it enters the tank so as to make as air-tight a connection as possible, blow into the tank. The pressure will force the gasoline out.

You may find that a tighter connection can be made by wrapping your pocket handkerchief around your fingers.

Fig. 4. Blowing into the auto gas tank forces gasoline through a siphon tube into a container.

When the Battery Is Dead

IF THE battery is so low that the car won't start, even with the hand crank, a couple of flashlight batteries will do the trick. Fig. 5 shows how to connect them. Remove the ignition coil wire leading to the ignition switch, and replace it with a wire from one end of the two flashlight batteries connected in series (you must have at least four cells). Then connect the other end of the two batteries to the metal crank case. Crank the motor, and when it starts, speed it up to send a charge through the storage battery. A few minutes' run will put enough charge in the battery so you can start the car again with the crank.

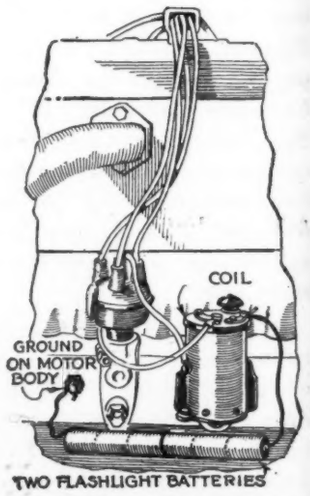


Fig. 5. How to wire two flashlight batteries to start the motor when storage battery is discharged.

What a cigarette meant there

Ten seconds to go—

and raw nerves fighting wearied muscles, driving them on into that fearful unknown beyond the wire. What man will *ever* forget the steadying solace of that last sweet stolen smoke?

What a cigarette means *here*

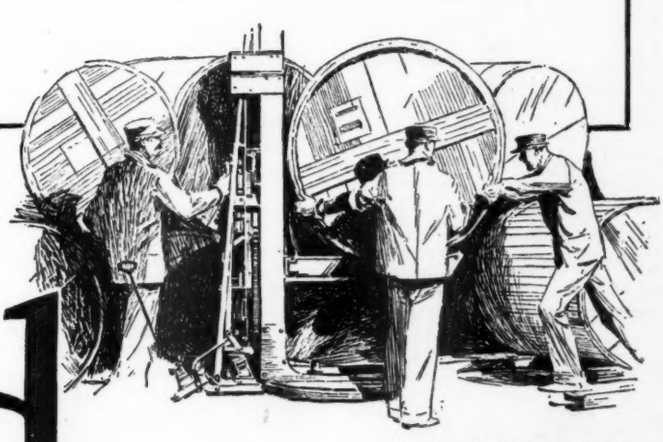
Two years to go—

the slow "ageing" by which tobaccos for Chesterfield lose all bite and harshness . . .

Mysterious, this chemistry of Nature! Endless rows of great hogsheads, stored away in darkness; choice tobacco, tightly packed . . . just waiting. And as if on signal, twice each year the leaf goes through a natural "sweat"—steeps in its own essences, grows mild and sweet and mellow.

Selected leaf, costly patience, endless care — that's what a cigarette means *here*. But right there is *exactly* the reason why Chesterfield means what it does to you!

Liggett & Myers Tobacco Co.

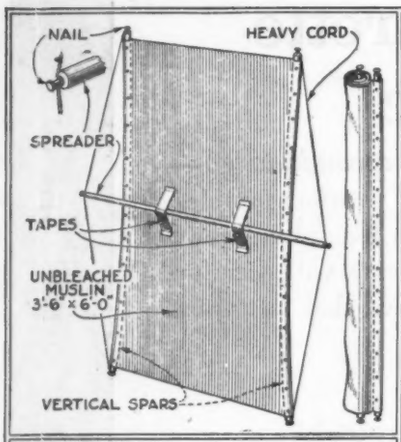


Millions of pounds of choice tobacco from each crop are stored away in great warehouses to "age."

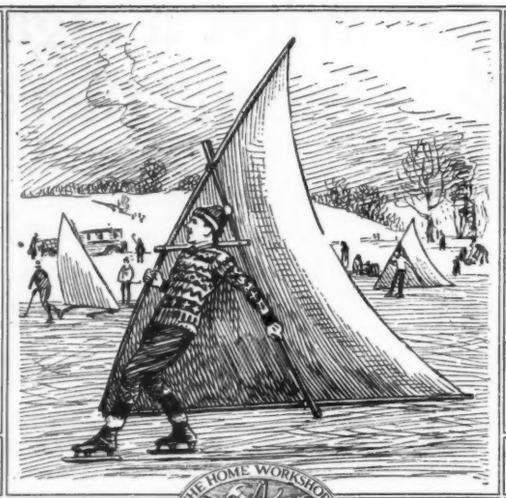
field

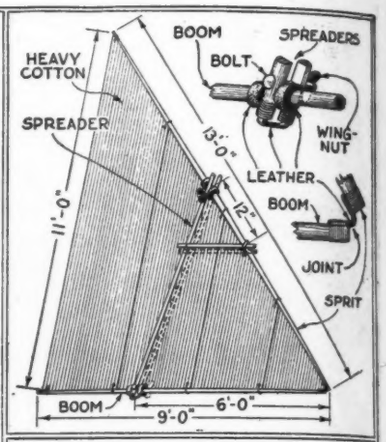
. . . . *and yet* THEY SATISFY

Now for Winter Sports!

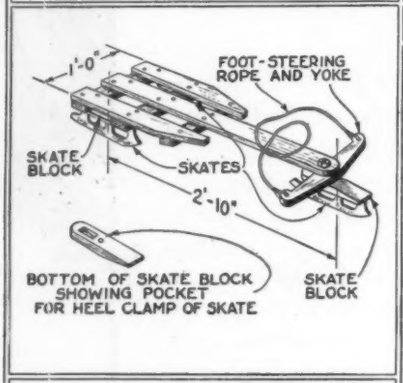


Simple type of square skate sail. Hold it behind you by the ends of the spreader.

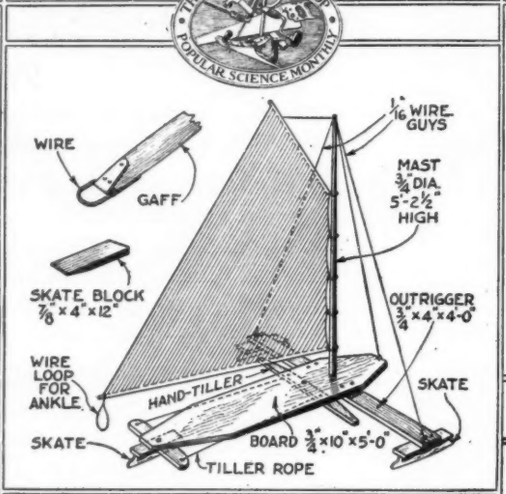




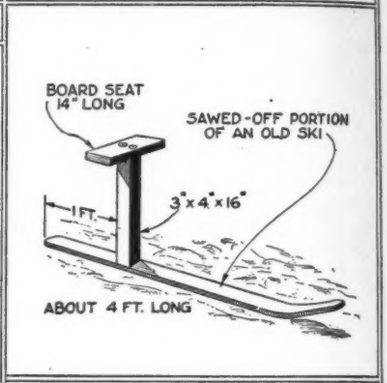
A skater with this type of triangular sail experiences the thrill of racing like the wind.



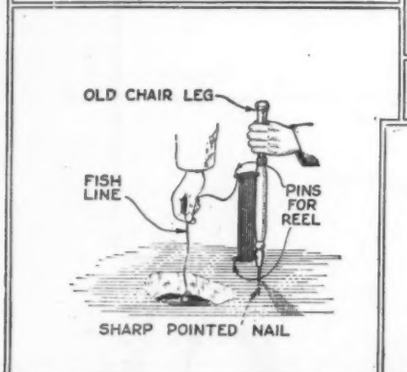
Steered with either hands or feet, this skate bob travels on ice or hard packed snow.



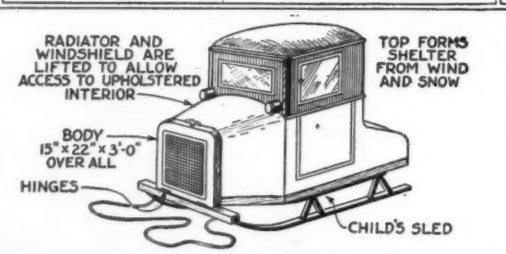
Lying flat on this tiny ice boat, a boy can control the sail easily by passing one of his feet through the wire loop.



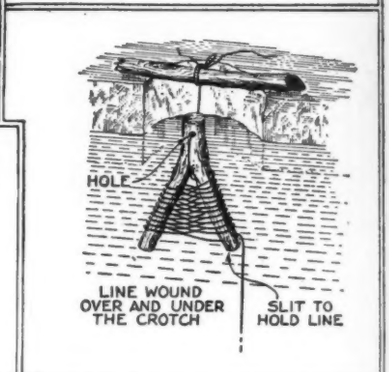
The front half of an old ski and two pieces of wood make this tricky, speedy coaster.



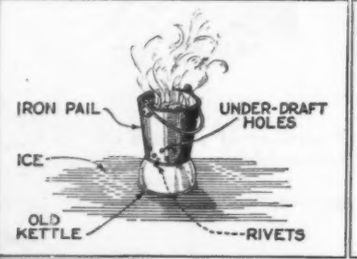
The instant the bobber dips, a fisherman can seize his line on this holder.


RADIATOR AND WINDSHIELD ARE LIFTED TO ALLOW ACCESS TO UPHOLSTERED INTERIOR
TOP FORMS SHELTER FROM WIND AND SNOW
BODY 15" x 22" x 3'-0" OVER ALL
HINGES
CHILD'S SLED

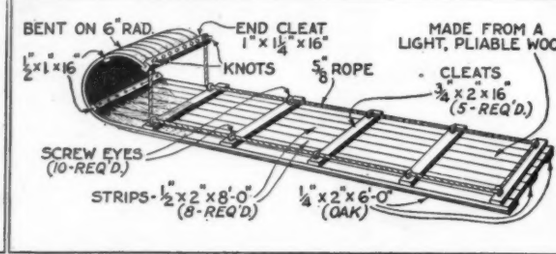
Auto sled to take the place of a baby carriage. The wood frame is covered with tin outside and upholstered inside.



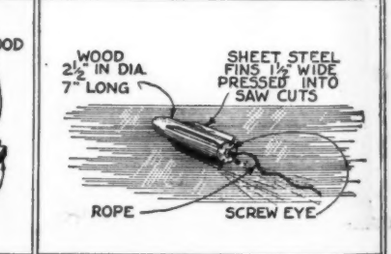
Set line for large game fish such as pike. It unwinds slowly and exhausts the fish.



A little charcoal or wood in this stove will warm a skater's chilled hands.

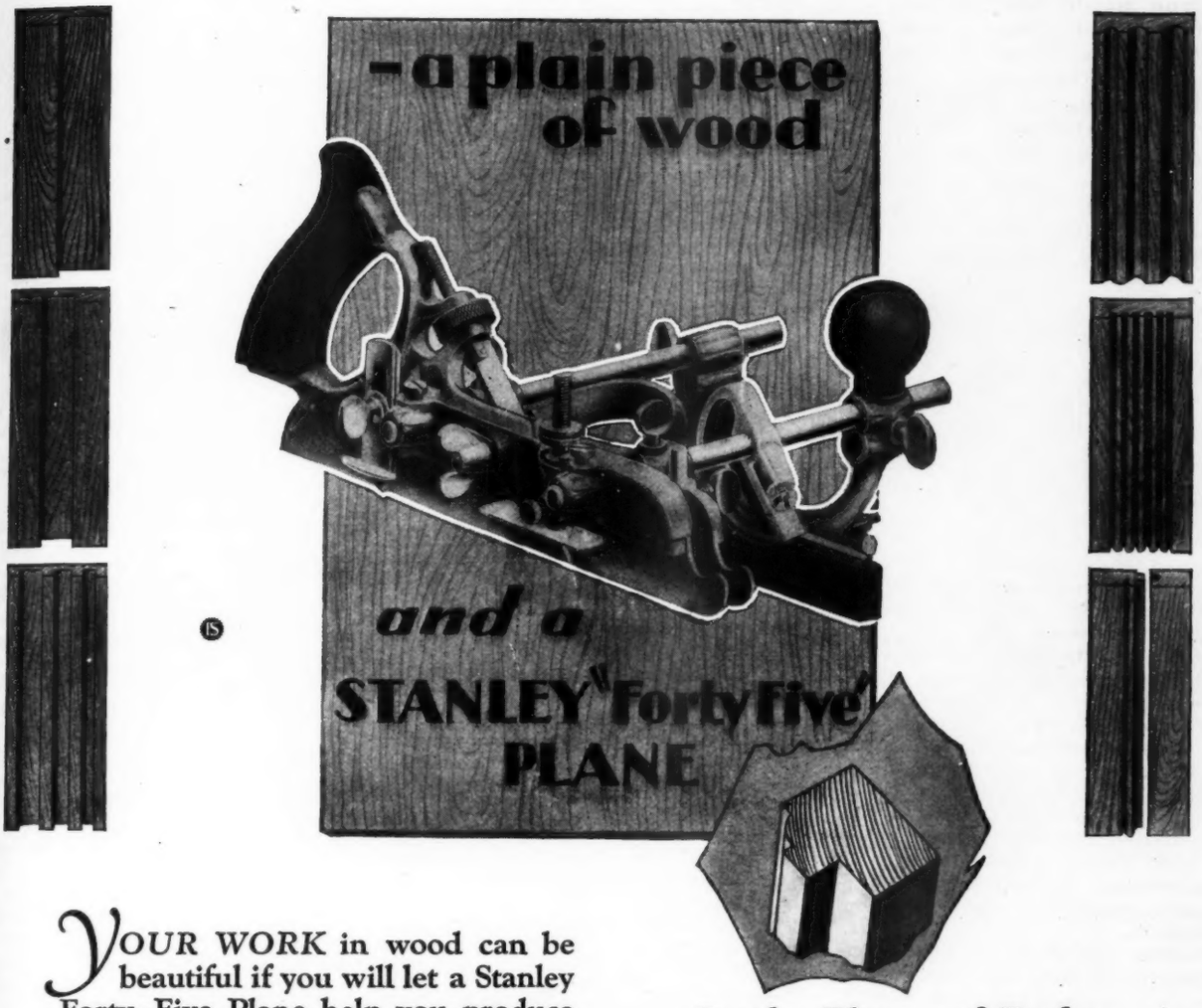

BENT ON 6" RAD.
END CLEAT 1" x 1 1/4" x 16"
MADE FROM A LIGHT, PLIABLE WOOD
1/2" x 1" x 16"
KNOTS
5/8" ROPE
CLEATS 3/4" x 2 x 16" (5-REQ'D.)
SCREW EYES (10-REQ'D.)
STRIPS-1/2" x 2" x 8'-0" (8-REQ'D.)
1/4" x 2" x 6'-0" (OAK)

Homemade toboggan. The front end of the bottom strips are planed thin, steamed or boiled, and bent around a form.



Ice torpedo to be slung on the end of a rope toward any suitable target.

For Decorative Woodwork



YOUR WORK in wood can be beautiful if you will let a Stanley Forty-Five Plane help you produce flutes, beads, reeds, rounded corners and other finishing touches.

This remarkable plane combines seven planes in one in a convenient and practical form. Furnished with a large number of cutters, it cuts rabbetts, dadoes and fillisters; and also does a great deal of work which ordinarily must be done in a woodworking shop.

Stanley Plans and Books

Stanley offers you a complete series of Plans giving step by step instructions for making 25 useful articles, also a book "How to Work with Tools and Wood" which is invaluable to the amateur for instructions in woodworking, finishing, etc.

Your hardware dealer can supply you with Stanley Plans and Books. If he does not have them, write us. The plans cost only 10 cents each, Books $1.00. Address The Stanley Rule & Level Plant, New Britain, Conn.

No. 1e—Book Rack
No. 2e—Candle Stick
No. 3e—Pipe Rack
No. 4e—Flower Box
No. 5e—Table Lamp
No. 6e—Toy Automobile
No. 7e—Sconce
No. 8e—Dinner Gong
No. 9e—Bird Houses
No. 10e—Dog House
No. 11e—Book Stand
No. 12e—Smoking Cabinet
No. 13e—Kitchen Cabinet
No. 14e—Sewing Cabinet
No. 15e—Cedar Chest
No. 16e—End Table
No. 17e—Tea Wagon
No. 18e—Model Sailboat
No. 19e—Combination Sail and Row-Boat
No. 20e—Combination Kitchen Seat and Step Ladder
No. 21e—Garden Seat
No. 22e—Garden Trellises
No. 70e—Small Tool Chest
No. 71e—Large Tool Chest
No. 72e—Work Bench

STANLEY TOOLS

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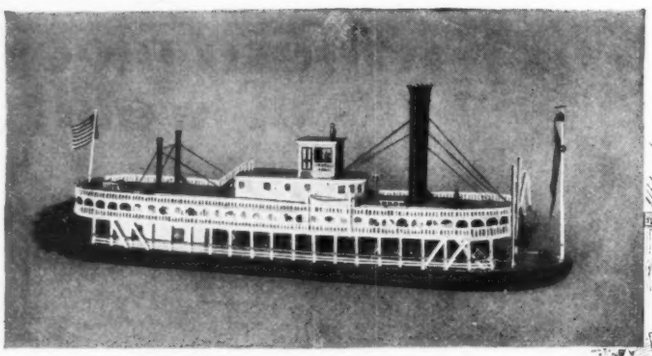
Building *the* "Buckeye State"

If you would like to construct a model of this famous old Mississippi River steamboat, you can begin now simply by sending for POPULAR SCIENCE MONTHLY Blueprints Nos. 94, 95, and 96, which contain complete full size drawings. Use the coupon on page 103. This is the fourth article of the series.

By
E. ARMITAGE McCANN
Master Mariner



The completed model of the ***Buckeye State***. The original boat was 235 ft. long with a 36-ft. beam and a 5-ft. depth of hold. The model, on a 1/12-in. scale, is 19½ in. long.

THOSE readers who are building a model of the stern-wheel Mississippi steamboat *Buckeye State* now have the hull complete with two decks and the cabin house on it.

Whether one is especially interested in the Mississippi River or not, this model is an attractive one to make because the *Buckeye State* is typical of the only completely American craft with the exception of the Indian canoe. It represents a type of steamboat evolved to serve 14,000 miles of winding rivers, for the most part very shallow. Even as far back as 1847, according to statistics gathered by Frank L. Coes, there were 958 river boats with approximately 200,000 tonnage, which was more than the steam tonnage of Great Britain. Indeed, the history of Mississippi steamboating is extraordinary throughout.

We have now progressed in the construction to the point where the third or upper deck is shaped and plank marked. This deck must now have square holes cut in it for the ladders. The two forward holes are ⅜ by ¾ in.; the after one is more nearly square. Now lay the deck aside for a time while doing other work.

Fix the two forward ladders in position with glue and by driving a pin point through the lowest step. Build safety rails around three sides of the openings.

DRILL ⅛-in. holes for the forward struts of the hog chains (actually Main Chain No. 2) as shown in Blueprint No. 95 and on page 102 of the January issue. These holes should be 3/16 in. from the edge of the deck at the positions shown. Bore down until the drill enters the lower deck. Drill a small hole for the chain or rod itself, and make another hole in line through the lower deck. Do not put the struts or chains in position yet.

Next place the struts supporting the extension of the cylinder beam to carry the wheel (see page 122). An upright post ⅛ in. square goes through the boiler deck and is set into the cylinder beam. Forward of this there is a strut half that thickness, butted to the top of the post and bolted to the inside of the beam. Abaft there is a similar strut running from near the top of the post to the beam about ⅜ in. inside of where the wheel bearing will be; and abaft that is another from the top of the post to nearly the end of the beam. Fit the latter but do not place it in position until the wheel is fixed. The other members may be glued and nailed. These ought also to have bar chains, but I think they may be omitted on so small a model. No. 22 wire, painted black, is used for all chains.

The upper deck may now be placed in position. I fixed mine by driving some pin points into the cabin for it to rest on, with some more above to keep it down. The points need project only 1/16 in. Brackets glued to the house underneath would make a better job, but perhaps are more trouble on so small a model than they areworth.

How the Bristol board rails are applied. Capt. McCann put them on in four sections, but time is saved by making them in two sections.

For the two rails below the handrail of the main deck, cut 1/16 in. wide strips of thin cardboard, such as three-ply Bristol board. Glue one side of these, clip one end in position, and stretch them along. This and other similar clipping is most easily done with ordinary spring clothespins, the points of which can be sawed to various shapes.

Next to be made are the side rails between the two decks and above the upper deck, together with their stanchions. These may be entirely fashioned from wood, but thin cardboard will make the work infinitely easier and will look almost as well. I made one piece to surround the space between the decks and another for the upper handrail, but it would have been better to have made the two in one piece as shown in the drawing on page 122.

As before advised, use only the very best cardboard, such as artist's three-ply Bristol. To go all the way around would take a very long strip, so it can be in two pieces, from right aft to right forward, amidships. First stretch an oversized piece right around, holding it in position with glass-headed pins. Mark on it the underside of the boiler deck, to get the sheer; also mark the center of every other of the lower stanchions. Remove it and draw the pattern, noting that one of the upper posts comes over every second lower post.

THE openings at the after end will have to be a trifle larger than at the other to make them balance. Slots will have to be cut in the lower edges to pass over the stern struts.

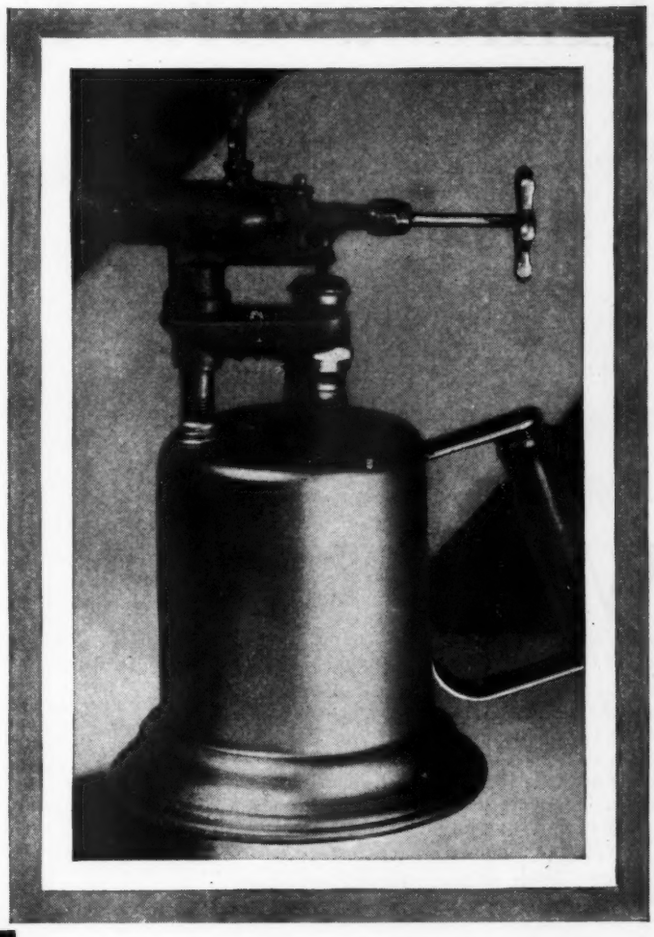
With a sharp-pointed knife or chisel, cut out the openings very neatly, leaving no burred edges. Do the cutting on a piece of glass or another piece of cardboard.

The lower edge projects 1/16 in. below the edge of the boiler deck and the upper edge is ¼ in. above the upper deck.

On the outside glue thin strips of cardboard along the (*Continued on page 122*)

C & L 158

This blow-torch is especially made and priced for the man who likes to do odd jobs around the house, or to tinker with mechanical things. It will last a lifetime if it is not abused. The usual retail price is about five dollars. Most hardware, electrical and automobile accessory stores have it—or can get it for you quickly. Look for the gold-banded, red handle.



Is the Feeling for Fine Tools in Your Blood?

DO YOU get a real kick when you pick up a good tool? One that makes working a pleasure? That makes you want to stick at the job? Well, be set to feel that way when you take up a Clayton & Lambert blow-torch.

In a Clayton & Lambert you buy all the exactness and pride that can be put into a blow-torch. You get materials that have proved their value by use. You obtain the result of 40 years' experiment and invention—exclusive Clayton & Lambert improvements. In construction and mechanism, Clayton & Lamberts are made with an eye for long, efficient service.

For instance—the vaporizing chamber has an exclusive vein system for quicker, hotter heat. That makes the torch function better and saves money on your fuel bills. All fittings are built into the tank by a patented method that prevents their falling in or coming out. There's *absolutely no danger* of an explosion with a Clayton & Lambert torch. Even the most delicate part—the gas orifice—is fool-proof. In the No. 158 the orifice has a guard. The slightly higher priced No. 32 has a patented control valve so that you'll never ruin the torch by a careless twist of your wrist. And when you close the valve you automatically clean out the carbon.

C & L 32

This is one of the most popular blow-torches we have ever made. It is more expensive than the 158 because it is made for much harder use. It is designed for the man who uses a blow-torch in his daily business and demands not only excellent performance but rugged ability to stand rough handling. 32 contains the most advanced, patented C & L blow-torch improvements.

The next time you're in a hardware or electrical store look for the blow-torch with a gold-banded, red handle. Be sure of the handle—it marks a Clayton & Lambert. Then you're getting the largest selling torch in the world.

Clayton & Lambert

Manufacturing Company, Detroit, Mich.

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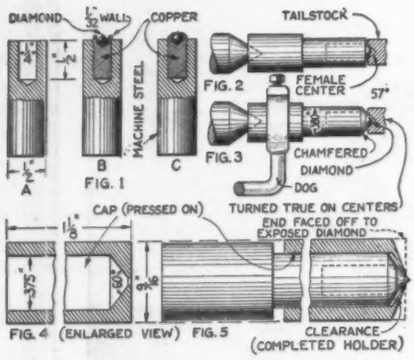
Timesavers for Shop Men



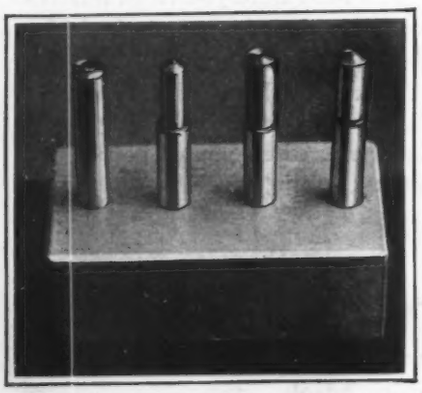
Steps in setting a black diamond in a holder for use in dressing grinding wheels accurately.

WITH the increasing use of diamonds in machine shops, many men have become very familiar with their care and setting. Diamonds can be purchased either set or unset. If they are bought set, they usually have to be reset after a time, depending upon the quality of the diamonds and the service to which they are put.

The stones used for dressing grinding wheels are what are known as black diamonds. There are several grades, but it is usually economy to buy a good diamond, as it will give much more return for the money invested. Also, it is well to get a diamond large enough for the work, just as when buying a monkey wrench.

Most diamonds are brazed into a steel holder. While brazing has been used with apparently good results for many years, much attention has been given to other methods. One result of this study has been the use of metals other than brass that melt at relatively low temperatures. This has been carried so far in one instance as to make a setting that will soften and release the diamond should it reach 800 degrees F. in service. The method was devised to avoid damaging the diamond, yet if overheating in service is likely to damage the jewel, as experts maintain, why will not heating it to 1,600 or 1,800 degrees in the setting also be detrimental?

This thought led to the development of the method of setting shown in the illustrations in this column. The diamond is held just as securely and is not heated in setting.



A mounted diamond and holders in three stages of completion. No brazing is required.

The first steps are shown in Fig. 1. A hole should be drilled about ½ in. deep in the machine-steel diamond holder. This hole should be about 1/16 in. larger than the diamond. Into the hole is driven a piece of copper rod, which is allowed to project 1/16 in. A hole just large enough to fit the diamond is drilled into the end of the copper plug deep enough to receive the diamond so that the point is just flush with the end of the plug. Then the copper is carefully peened over the diamond with a small set. Of course, this peening must be gently done to avoid fracturing the stone. The point of the diamond should be kept in the center of the holder as nearly as possible.

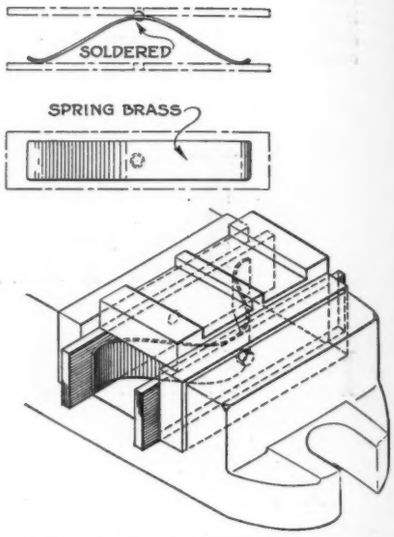
The holder is next turned on the outside true with the diamond. This is done by centering the rear end of the holder, and running the diamond in a female center held in the tailstock of the lathe. The female center is made by drilling a small hole in a piece of ¼-in. stock held in the chuck and allowing the diamond to true up the hole to fit itself (Fig. 2). A little emery and oil will assist.

Next, the end of the holder is chamfered to an angle of about 57 degrees, as shown in Fig. 3.

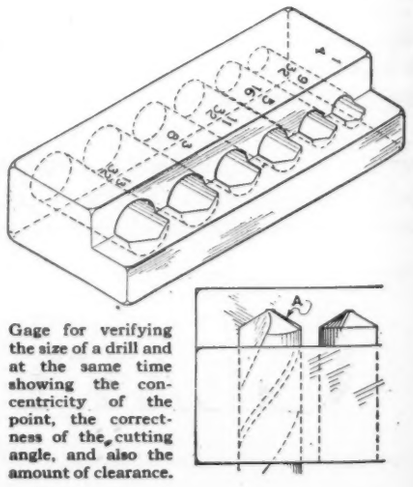
A cap is made from 9/16-in. stock and reamed to press over the turned portion of the holder as shown in Fig. 4. The bottom of this cap must be reamed with a reamer having an included angle of 60 degrees or slightly greater than the angle of the chamfered point. This is so that when the two are assembled the cap will bear on the point of the diamond only. A hole about half the diameter of the diamond is drilled through the end of the cap.

The cap is pressed on the holder and its end faced off as shown in Fig. 5 to expose the diamond. This completes the setting, which should take about one and a half hours, after the first trial.

The diamond should not project beyond the cap any *(Continued on page 115)*



Thin, springy spreader used to support parallels under flat work held in a vise.



Gage for verifying the size of a drill and at the same time showing the concentricity of the point, the correctness of the cutting angle, and also the amount of clearance.

Old Bill *Says*—

WHEN you are forming a radius on the corners of an end mill or a side mill, use a fine grain wheel to get a smooth finish.

The average small shop generally has poor equipment for testing a lathe taper set-up; it is safest to take figures at both ends of the work. But don't use a file to get results!

Don't throw a piece of machinery steel into the tool steel scrap box. If you do, some other mechanic, if not yourself, is likely to get into trouble.

When a grinding wheel has a tendency to burn the work, cut notches 1/8 in. deep with an old file at every inch of the circumference. This will help materially to cool the work.

They, *too*, need Starrett Accuracy

In the manufacture and maintenance of millions of motor vehicles, Starrett Tools are playing a part of vital importance. Countless thousands of motor mechanics put their faith in the accuracy and lasting dependability of Starrett Tools.

If you, too, appreciate the value of Starrett standards of quality and workmanship, be sure and ask your dealer for Starretts. Look for the name on every tool. Ask us to send you Starrett Catalog No. 24"W" containing full descriptions and prices of over 2500 tools.

THE L. S. STARRETT CO.
World's Greatest Toolmakers
Manufacturers of Hacksaws Unexcelled
Steel Tapes—Standard for Accuracy
ATHOL, MASS., U. S. A.

Use Starrett Tools

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Turning Oversize Work in a Lathe

How to Prevent Sagging—Saving Strain by Use of a Faceplate in Place of a Chuck—Steady-Rests

By HENRY SIMON

Much ingenuity is often required to set up a heavy and awkward casting in a small lathe.

LATHE work, as a rule, is balanced statically. In large and ponderous castings revolving at slow speed, this is all that is required to counteract the gravitational pull which might otherwise cause uneven running of the spindle under the changing eccentric load. Balance, however, is not always the only point which has to be considered. With very heavy work, the weight of the work itself, whether it is eccentric and unsymmetrical or not, becomes a factor when it is large in proportion to the size of the lathe.

What is meant is shown in Fig. 5, page 114, at *A*. The heavy weight of the large casting causes a bending moment in the spindle, which is thus deflected downward and in turn disaligns the work. The spindle itself may spring slightly; certainly there will be "give" in the threads of the spindle nose, as well as in the various parts of the chuck or in the web of the faceplate. What actually happens is that the part revolves around an axis of which the front portion is at an angle to the rear portion, producing an effect somewhat similar to that of a flexible or universal-joint shaft. Many exasperating errors in costly jobs are due to this condition without the cause being recognized.

Even where it can be applied, the indicator does not show this kind of error because the plane in which the faceplate or chuck revolves, while inclined at an angle to the vertical, remains parallel to the traverse of the compound rest on which the indicator is held, as may be seen from the diagram at *B*, Fig. 5. Even where the work already has a true cylindrical surface that can be indicated, this error usually goes unnoticed because, especially with large work, the mechanic applies the indicator to the side. So used, the indicator will show eccentricity, but it cannot show sag or deflection of the spindle.

The difference can be seen in Fig. 4. It will be noted that while the movement of the eccentric piece at *A* must be registered no matter which way the indicator is applied, the piece held on the deflected spindle at *B* describes a path concentric with the spindle axis at that point, and the indicator will therefore be at rest. As the sag is only downward, the error cannot be seen by running the indicator along the side of the work, as at *a* in diagram *C*. It should, instead, be run along the top or bottom as at *b*.

Now, it might be argued that as the indicator run along the side does not show the existence of any sag, so no trouble will result by applying a tool under the same circumstances. This may or may not be true. There will be no noticeable error if the diameter to be turned is large and the tool is applied almost exactly central. Particularly with bores, however, the diameter is often comparatively small even in large work. And in bores as well as outside turns, the tool is usually applied below or above center.

Some of the resulting possibilities are shown in the diagrams and table of Fig. 2, where it will be seen that the error caused by having the boring tool ¾ in. off center in a 1-in. hole results in a taper of .0007 in. in a bore 6 in. long, even with a sag of only .0005 in. per running inch.

WITH the sag increased to .001 in.—or less than ¼ in. over the entire 15-in. length from the front spindle bearing to the end of the work—the difference rises to .0015 in., which is more than enough to spoil many a piece of work. It is interesting to note, and will sometimes be useful to remember, that with the tool above center as at *A*, the bore will be tapered outward, while it will be larger at the inner end when the tool is below center, as indicated in Fig. 2 at *B*.

Now the evident remedy for spindle sag would be to use a heavy enough lathe for heavy work. This is excellent advice, and would be even better if it could always be followed. But most of us are not in the fortunate position of being able to pick the right tool every time, and the faithful little old lathe will have to continue handling many a job that stretches its capacity. There are ways out of almost everything, however, and so there are ways out here.

With smaller holes, the use of an expansible reamer (*Continued on page 113*)

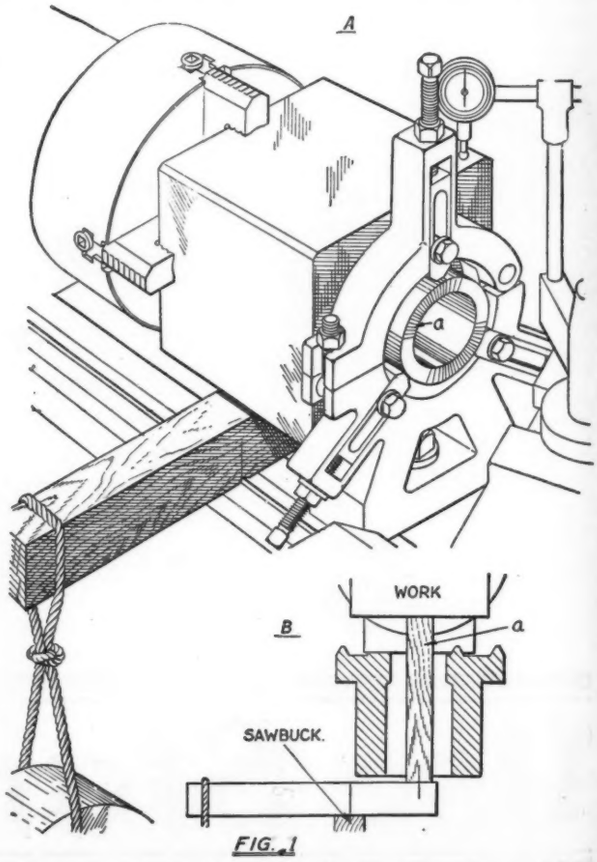
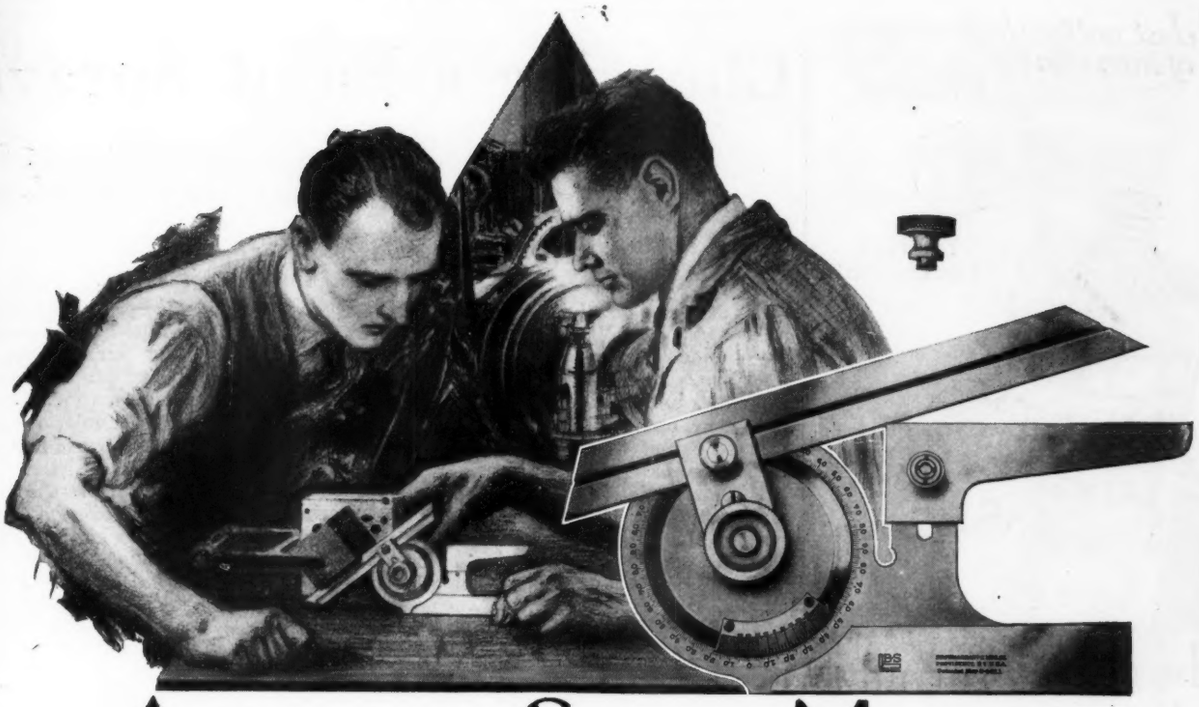
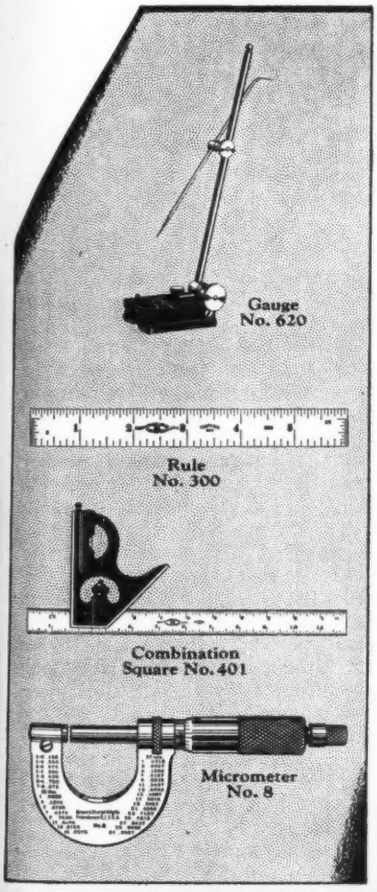


FIG. 1

Setting up a casting on which a "stub" or extension has been provided and turned to a suitable diameter to allow a steady-rest to be used.



Accuracy Grows More And More Important



In many cases, today's product must be held to limits closer than one thousandth of an inch where yesterday's passed muster at less exacting standards. Why? Simply because today's manufacturer has learned that faster and more profitable production follows close in the wake of smaller tolerances, or working limits.

All along the line, fine measuring tools are needed to make high precision standards possible. Manufacturers, tool-makers, and mechanics everywhere rely for this work on Brown & Sharpe Tools, known the world over for their quality and unfailing accuracy.

The tool shown above is Bevel Protractor No. 496. Get a copy of Catalog No. 30, describing this and over 2300 other Brown & Sharpe Tools, from your hardware dealer. Or write us for one. Address Dept. P. S., Brown & Sharpe Mfg. Company, Providence, Rhode Island, U. S. A.

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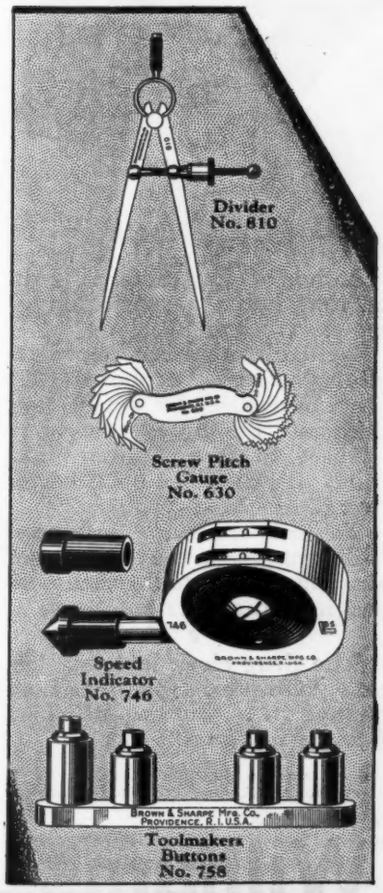
WORLD'S STANDARD OF ACCURACY



BROWN & SHARPE TOOLS

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"Just notice the fine skins of men who use Williams"

You *can't* lose *this* cap!

The Cream that *leaves* FACES FIT!

Texture!

Lather of close texture is lather that holds a maximum of moisture.

Williams lather is lather of the closest texture. It holds 10% more moisture, by actual test, than any other we know of.

Lather of close texture is super mild. It's the thin, open lather that roughens and stings.

Texture—moisture—mildness! Williams gives a new glimpse of shaving comfort to the man who uses it for the first time.

The drug clerk knows. Listen: "Oh, yes, sometimes they change . . . . *but they all come back to Williams!*"

THE J. B. WILLIAMS COMPANY,
GLASTONBURY, CONN.—MONTREAL, CANADA.

Next time say

"Williams Shaving Cream *please!*"

Afterwards find out how perfectly AQUA VELVA completes the shave. Made *just* for that.

Choosing a Paint Sprayer

F. N. VANDERWALKER *Describes the Various Types of "Guns" Available for Home Decorating*

"I HAVE just been looking at two or three paint spray guns," a friend of mine remarked to me not long ago. "They sell at less than $40 and look excellent. I would like your opinion as to which one it would be best to buy for painting the three large barns on my farm."

His was an innocent request for information typical of a thousand and one questions being asked by amateur painters and decorators who wish to take advantage of the spray guns being sold for home use. And it is not always easy to obtain informative answers.

The would-be purchaser is told that they are great labor-saving tools for the application of paint, lacquer, enamel, varnishes, and other decorative and protective coatings. He has to explore a bit for himself before he can hope to find the limitations of the half a dozen or more types of spray guns.

Let us see just how the spray gun works and we shall better understand what constitute reasonable expectations from this most useful tool. The spray gun is a tool through which a stream of air and a stream of paint, lacquer, varnish, or other liquid are passed; the air breaks up the liquid, atomizing it and projecting it upon the surface to be coated. Some types permit the atomization to be controlled exactly as to uniformity and volume; others allow only a partial control.

In the simplest type of gun the paint or other liquid is supplied from a container near the nozzle by siphonage. One end of a small tube or pipe is inserted into the liquid and its other end opens just back of the nozzle hole in the end of the gun. When a stream of air is projected past the upper opening, the liquid rises through the tube; the air stream then atomizes and projects it on the surface being painted or otherwise decorated. A study of the tabulation on page 100 will show that the types marked *A*, *B*, *C*, and *F* use the simple siphon system.

In a second type of sprayer the material is contained in a cup above the gun or in a large container from which a hose leads to the nozzle, and the feed is by gravity.

A third type is fed by pressure. The material is carried in a tank lower than the gun and a pressure of from five to thirty or forty pounds is applied in the tank to force the liquid to flow up into the gun.

The kind and amount of work you wish to do govern your choice of a spray gun.

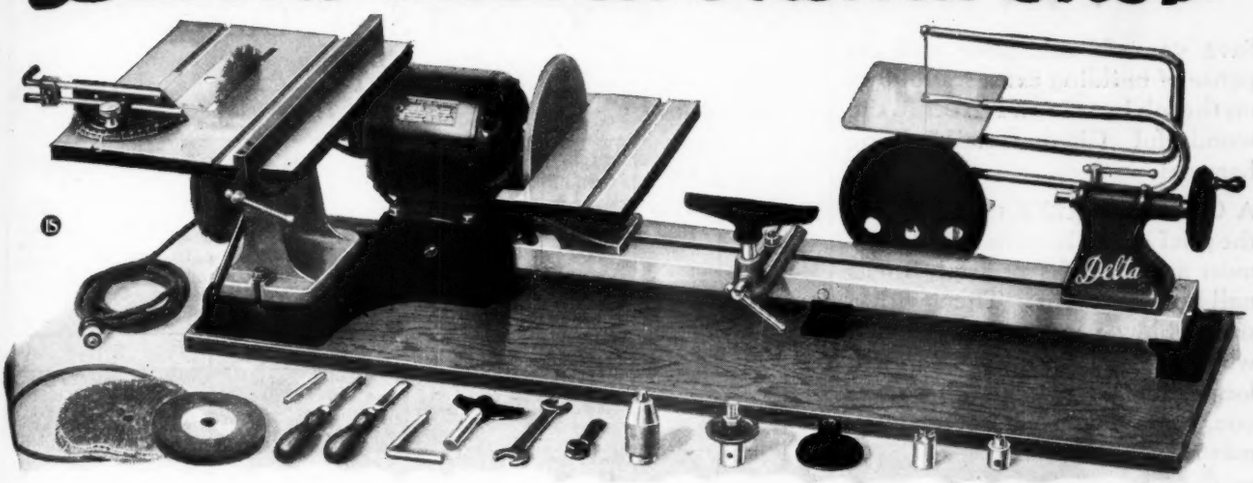
It is obvious that a heavy liquid, such as paint weighing from fourteen to twenty pounds a gallon, will require an air stream at higher pressure to lift it to the gun and to atomize it than a wood stain or thin lacquer which does not weigh nearly so much. Consequently, it is well to thin the heavier liquid with from ten to twenty-five percent of turpentine, benzine, or lacquer thinners in order to make them spray to best advantage when the air supply is limited—and, indeed, sometimes when it is not.

Generally speaking, there are two types of guns. One requires a relatively high pressure—from forty to sixty pounds—and less volume of air than the other. The ports or holes in the nozzle of high-pressure guns are smaller than in the low-pressure types, which use a much larger volume of air at a pressure of about twenty pounds.

The three air supply factors are pressure, volume, and duration. The capacity of a spray gun of any type is limited by these factors. Spray guns such as those marked *A*, *B*, *C*, *D*, and *E*, which are supplied with air by means of a hand or foot (*Continued on page 100*)

The spray gun above is of the professional type used with a large pressure-feed outfit. The one at the left is of the siphon-feed type and has a small glass container for the paint.

Here is a Husky Man-Size Workshop
The New 1929 Model Complete Practical
"Delta" Electric Handi-Shop



New Features of 1929 Model

found *exclusively* in the "Delta" Handi-Shop, in addition to the many regular exclusive advantages, make this shop one of the finest values in the workshop field. A few of the new improvements are:

New Delta Miter-Gauge (with many new features).
New Circular Saw Adjusting Lever.
New Delta Adjustable Rip Gauge.
Larger Circular Saw Table.
1/3 H. P. Motor.
Larger Triple Foundation Lathe Bed.
1/2 inch capacity Drill Chuck.

For full details, send coupon below.

Make the Things You Have Always Wanted to Make

With this convenient, practical workshop. It's *so easy* and *so quick*. Save money on repair work. Earn money in your spare time. Complete instructions furnished. With each Handi-Shop is included, at no extra cost, complete set of working drawings. Below are a few of the hundreds of articles you can make in a jiffy with a Handi-Shop.

Blue Prints Included

DOES EVERYTHING FROM BUILDING FULL-SIZED FURNITURE TO TURNING 36" TABLE LEGS

Note the **two-shaft motor** that permits **two or three operations at one time**—the heavy Triple Foundation U-shaped Lathe Bed (no rods)—the *practical* arrangement of the Circular Saw that permits the cutting of large lumber without interference—the Improved Tilting Tables on the Circular Saw, Sanding Disc and Jig Saw, with many exclusive features. Has **automatically oiled** bronze bearings and is **completely assembled** on heavy veneered wood base.

This combination of advantages, plus many more, IS FOUND EXCLUSIVELY in the DELTA HANDI-SHOP! No wonder even last year's Handi-Shop was an outstanding value. **And now, with the many additional exclusive features of the new 1929 model, this shop is in a class by itself—above all comparison—at a new price that is surprisingly low.**

This TWO-SHAFT motor is THE practical motor for the workshop. Permits you to carry on two or three important operations at one time — **without continually dismantling the set-up.**

ALL DELTA UNITS have 36 in. lathe capacity between centers

This Heavy Triple Foundation U-Shaped Lathe Bed (not rods or rails) is GUARANTEED not to spring or chatter.

10 DAY TRIAL in Your Own Home

without obligation. See how PRACTICAL, how EFFICIENT is this sturdy, full-sized machinery under **actual working conditions.** Study its many exclusive advantages. You will find the Handi-Shop complete with all necessary equipment for **Circular Sawing, Woodturning, Jig Sawing, Sanding, Drilling, Grinding** and **Buffing.**

Easy Terms

Then if you decide to keep the Handi-Shop, you can have your choice of three convenient methods of payment.

Send Coupon

at once for **Free** beautifully illustrated literature giving complete description of the New 1929 Model "Delta" Handi-Shop, with its many exclusive advantages and new features. Also full details of the 10 Day Trial Offer and Convenient Payment Plans.

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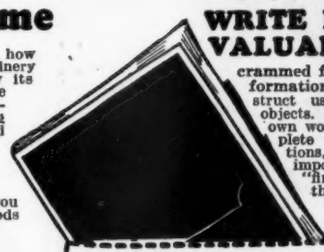

crammed full of practical information on how to construct useful and decorative objects. Helpful whether you own workshop or not. Complete directions, illustrations, diagrams. Contains important information on "finishing." If you want this book, send 10c, which merely covers cost of mailing. See coupon below.

DELTA SPECIALTY CO. Dept. B-29
1661-67 Holton St., Milwaukee, Wis.

(Check material desired)

☐ Please send, without obligation, **FREE** illustrated literature describing new 1929 Model Delta Handi-Shop. Also full details of 10 Day Trial Offer and Easy Payment Plans.

☐ Please send me copy of **"How to Make Things with a Workshop."** I enclose 10c to cover cost of mailing.

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Address.....

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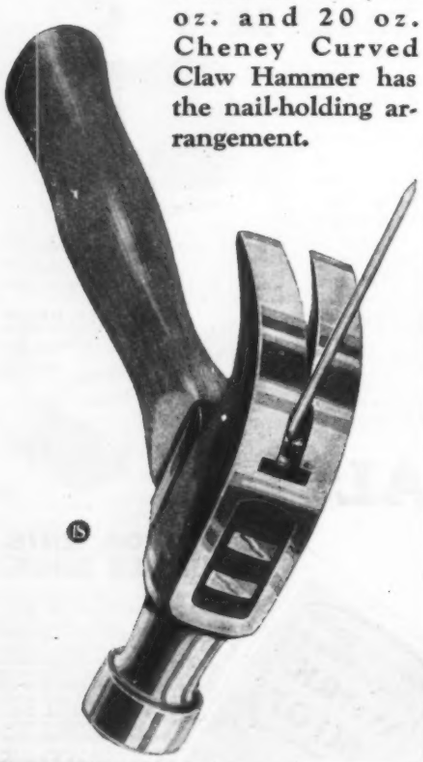
A Cheney NAILER *Will Make the Day's Work EASIER*

▼ ▼ ▼

Save yourself the labor and expense of building extra scaffolding on the job by using a NAILER, the wonderful Cheney nail-holding hammer.

A Cheney NAILER takes a lot of the grief out of hammer work. Almost any nail fits perfectly in its nail-holding niche. Then with a single blow you can set the nail wherever you want it. The extra long reach obtained is what saves your time. The weight of the hammer releases the nail.

This easy one-hand nailing will save you many bruised fingers as well as labor and time. Try a handy NAILER. Every 16 oz. and 20 oz. Cheney Curved Claw Hammer has the nail-holding arrangement.



PRENTISS VISES
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106-110 LAFAYETTE ST. NEW YORK CITY
CHENEY HAMMERS
2464

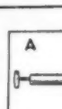
Choosing a Paint Sprayer

(*Continued from page 98*)

pump or a very small electric motor, necessarily are limited in air volume and air pressure. The hand and foot pump types also are limited in the duration of the supply; that is, the air supply is not as steady as it is with an electric motor.

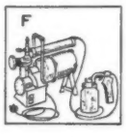
decorating surfaces of a limited size. With the smaller guns it is impractical but not impossible to paint large surfaces.

Spray guns supplied with air by electric motors—those having a tiny motor mounted directly on the gun or located separately near by—have greater capacity than those which depend upon hand or foot pumps. It is practical to use them for painting a garage, fence, or small room interior, and, of course, an automobile, but they will hardly serve for painting a large house or a barn.

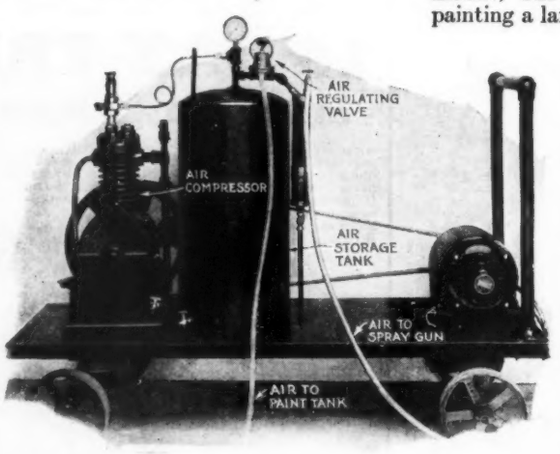


Types of Spray Guns and Their Uses

Type	Price	Air Supply	Pressure	Feed	Regulation	Materials Handled	Surfaces Practical to Finish
A	$2.00	Hand pump	Low	Siphon	Limited	Paint, lacquer, enamel, varnish, stain, sizes	Furniture, touch-up work, radiators, picture frames, auto fenders, all small objects
B	$4.50 to $15.00	Foot pump	Low	Siphon	Limited	Same	Same
C	$4.50	Vacuum cleaner	Low	Siphon	Less limited	Same	Same
D	$35.00	Very small electric motor	Low	Siphon and pressure	Certain	Same	Furniture, radiators, small exterior bldgs., automobile refinishing, cabinet and interior house trim
E	$40.00	Very small electric motor	Low	Siphon and pressure	Certain	Same	Same
F	$100.00 to $150.00	¼ to ½ H.P. electric motor	High and low	Siphon	Certain	Same	Same, also larger surfaces
G	$300.00 $600.00 $1,000.00	1 H.P. and larger motors and gas engines	High and low	Siphon, gravity, pressure	Certain	All materials that can be brushed and others	Furniture, automobiles, interior trim, floors, walls, exterior of houses, barns, metal, brick, concrete, shingles, etc.



Because of these limitations, the practical usefulness of these hand and foot pump sprayers and the small motor types of spray guns is mainly for coating chairs, tables, radiators, and wicker furniture, for touching up automobiles, and for



Paint spraying outfit with air compressor driven by an electric motor. It can be used with either spray gun shown on page 98.

Among the small motor-driven spray guns there are, in general, three types. One mounts the motor on the spray gun handle and depends more upon a large volume of air at low pressure for atomizing the material than upon a smaller volume of air at high pressure; from twenty-five to thirty pounds pressure is the maximum of this type. The second type is that using the siphon principle gun and having a very small electric motor as a separate unit. These guns also come within the low-

(*Continued on page 107*)

This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

Cannon for Shooting Snowballs

By HI SIBLEY

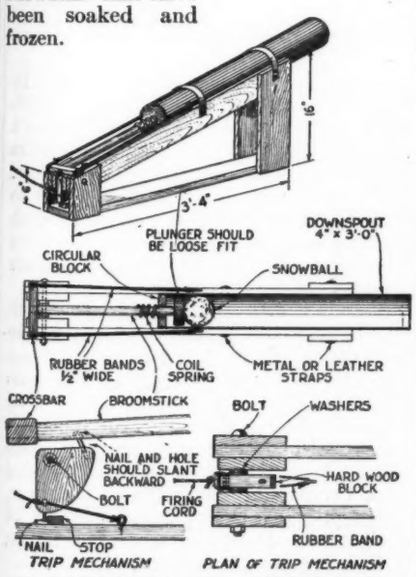
A length of old downspout or stovepipe forms the barrel of this unusual snowball howitzer.

AS THE winter campaign in the War of the Vacant Lots becomes more furious, defenders of the fort will need more powerful artillery. By constructing a snowball howitzer as shown, they can hold off a strong enemy force.

The power is obtained from ½ in. wide rubber bands cut from a discarded inner tube, preferably one which retains considerable elasticity. A coil spring is slipped over the broomstick before the firing mechanism is assembled to take up the shock of the plunger when firing.

Upon the neatness of the firing mechanism depends the efficiency of the howitzer. A ½-in. thick, hard wood block shaped as indicated forms the foundation of the trip. A rubber band holds the trip block in position until fired, and a stop at the bottom prevents the band from pulling the block too far forward. A cord is attached to the lower end of the block.

For ammunition, pack your shells from moist snow, but remember that the Committee on Armaments of the League of Vacant Lots absolutely outlaws any snowballs that have been soaked and frozen.



How the howitzer is made. Pulling the string releases the ingeniously simple mechanism.

Your only way to get "YANKEE" Efficiency

Up or down is the same to "Yankee" No. 130-A. Just push! This spring in the handle, with the "Yankee" Spiral, does the work. Great in tight places . . . one hand drives, or draws, screws.

SKILLED mechanics know the only way to get "YANKEE" efficiency is to get "Yankee" Tools. Amateurs and handymen can profit by that knowledge. . . . Safe rule always before you buy to see that "Yankee" is on the tool!

"Yankee" Spiral Ratchet Screw-drivers are the standard of the world.

To drive screws, just push. The "Yankee" Spiral does the work. Smooth! Easy! Shift to left-hand motion and you draw screws like a flash. Another touch gives you "Yankee" Ratchet movement for occasional heavy screw-driving.

Make sure! "Yankee" Tools may be copied in looks but not in workmanship. Ask your dealer for "Yankee" Tools. They stand up, give long service, are cheapest in the end.

No. 130-A is the "Yankee" Quick Return. Spring in handle brings it back for next stroke. Like a thing alive! Keeps blade in screw-slot. Leaves one hand free to hold work. Three bits. Price, $3.45.

No. 30-A is the standard style "Yankee" Spiral Ratchet Screw-driver, without spring in handle. Three bits. Price, $3.00.

Made also in Heavy and Light patterns.

Three sizes of bits with each tool. Each bit tested.

Right and left spiral, right and left ratchet, and rigid adjustments.

Chuck and Drill Points enable you to drill holes with spiral screw-drivers. Eight drill points, 1/8 to 11/64 (same as for "Yankee" Push Drills) with chuck to fit spiral drivers, sold separately in wooden box.

"YANKEE" TOOLS

Make Better Mechanics

Mail Coupon

Get "Yankee" Tool Book with action pictures showing how the ingenuity of "Yankee" Tools will help you make things, saving your time and labor.

North Bros. Mfg. Co.,
Philadelphia, U. S. A. Send Tool Book Mentioned in Popular Science Monthly.

Name and Address.....

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HERE'S THE BLADE YOU WANT

When you buy hack saw blades you can be assured of the best blade money can buy, when you ask for STAR.

For faster accurate cutting with practically no breakage, the STAR BLADE is unexcelled.

Special tempering of each blade gives strength and cutting qualities that are unsurpassed. The uniform excellency of each blade has won a world wide reputation for STAR HACK SAWS.

Let us send you free working samples.

CLEMSON BROS., INC.
MIDDLETOWN, N. Y.

Makers Since 1883

Upholstering Old Chairs

By R. C. STANLEY

Fig. 1. A comfortable rocking chair salvaged from the one in Fig. 2.

Fig. 2. If this chair could be repaired, is any chair beyond hope?

DISCARDED chairs, whether modern or antique, can be salvaged in many cases by replacing the upholstery or by substituting upholstery for rush, splint, or other types of seats.

It is surprising what can be done with an apparently hopeless-looking chair. Some can be made fully as good as new; others, less attractive in their original design, can, nevertheless, be made comfortable and serviceable for use in a spare room, a child's room, or other room where extra seats are needed.

The chair shown in Fig. 2 was junked until the writer salvaged it to serve as an illustration of what can be accomplished in repairing a particularly poor specimen. Figure 1 is the same chair with all of the old willow removed and the old back replaced by a "slat and spindle" back. The new seat is of the bar and spring type, pieces having been added to form an apron to prevent the springs from showing underneath. Note in Fig. 3 how the springs are tied to keep them in position.

In Fig. 4 is shown a very important part in the reconstruction of seats. Two layers of the best grade of burlap have been stretched over the springs and tacked to the apron. A ¾-in. wooden rod is nailed to the top of the apron to form a "roll," which holds the seat filling in position and retains the shape given the new seat. This "roll" also may be made with rope or with flax tow twisted into a roll and similarly nailed.

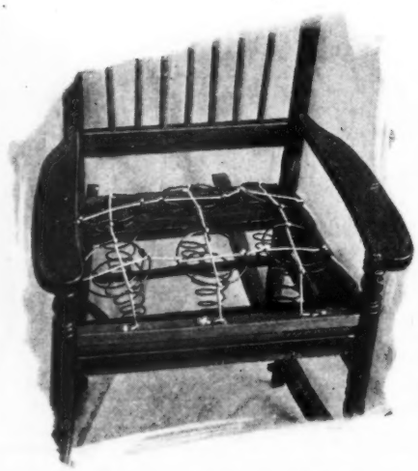

Fig. 3. The bar and spring method of upholstering a seat. Note how the springs are tied.

The next step is to fill the seat with a good grade of flax tow. There are a number of materials with which seats may be filled, but tow is preferred by the writer, who has removed upholstery fillings of every description from old furniture and has found none to be in as good condition after a number of years of hard service as the tow. I have removed tow that was known to be well over a hundred years old, knocked the dust out of it, pulled it apart to "fluff it up," and used it again in the same job; it was as good as when new.

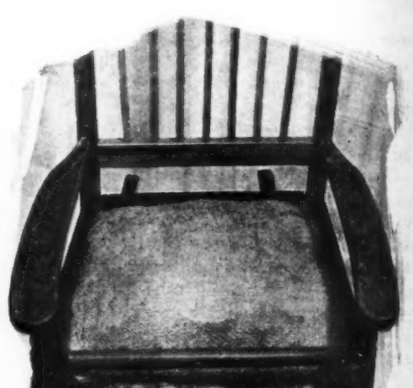

Fig. 4. The springs are covered with two layers of burlap and a rod is added to form a "roll."

Fill the seat well and evenly; don't skimp the filling. The reason for all chairs is the seat, which should be comfortable.

Three pounds of tow were required to fill the seat as shown in Fig. 1. Stretch burlap or any kind of cloth over the filled seat and tack it to the apron; this gives the seat the form desired.

Now is the time to clean and refinish the chair. If this part of the job were the first to be done, it would more than likely have to be done over again after so much handling. The chair illustrated originally had a clear varnish finish; it was refinished with mahogany varnish stain. Figure 1 shows it a better and more comfortable chair than when new, although with this particular kind of chair it is hard to decide where it belongs; it is being used now in a bedroom.

After the job is refinished, the final covering is put on. (*Continued on page 110*)

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Blueprints for Your Home Workshop

OUR blueprints can be obtained for 25 cents a sheet. In some cases there are two or three sheets to one subject. The blueprints are complete in themselves, but if you wish the corresponding back issue of the magazine in which the project was described in detail, it can be had for 25 cents additional so long as copies are available. Other subjects besides those below are to be had; send a stamped envelope for the complete list.

Popular Science Monthly,
250 Fourth Avenue, New York

Send me the blueprint, or blueprints, I have underlined below, for which I inclose .....
.....dollars.....cents

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2.	Smoking Cabinet	*Mar.,	'22	25c
5.	Kitchen Cabinet	*May,	'22	25c
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27.	Kitchen-Cabinet Table	Oct.,	'23	25c
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39.	Salem Chest of Drawers	*Feb.,	'25	25c
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44-45.	Pirate Ship Model	*Feb.,	'26	50c
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67.	Toy Model of Lindbergh's New York-to-Paris Plane	Aug.,	'27	25c
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73.	Doll's House Furniture	Dec.,	'27	25c
74-75-76.	*Santa Maria* Ship Model, 18 in. long hull	Dec.,	'27	75c
77.	Simple Pier Cabinet and Decorative Wall Shelves	Jan.,	'28	25c
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Buy Later

First **Make This Remarkable Test for 7 days . . . Prove This Unique Shaving Cream's Supremacy . . .** ***Buy*** **Only if Convinced.**

Mail Coupon Now.

GENTLEMEN:

Most manufacturers clamor for immediate sales. "Buy this!" "Buy that!" they urge. But we have found success in urging men *not* to buy. Rather, to find out at our expense if they like our product. For if they do, they'll buy, and they'll tell others.

Such is the basis of the spectacular success of Palmolive Shaving Cream.

The great majority of men who make our test become regular users. Remember they, like you, were wedded to some other shaving cream before.

The coupon is for your convenience. Even though you customarily do not use coupons, please send this one in. In fairness to yourself and to us.

How it was discovered

When we set out to make a shaving cream, we asked 1000 men what their wishes were. They gave us four objectives. Our great laboratories set to work. Time after time we tried, 129 in all, before we got the formula that brought success.

To the 4 things men asked, we added a fifth. Today we believe Palmolive Shaving Cream is supreme for shaving comfort. Men tell us no other compares.

These 5 Things

The things you get in your 7-day test of Palmolive, are things you have long sought:

1. Multiplies itself in lather 250 times.
2. Softens the beard in one minute.
3. Maintains its creamy fullness for 10 minutes on the face.
4. Strong bubbles hold the hairs erect for cutting.
5. Fine after-effects due to palm and olive oil content.

Now we ask a test

No doubt your present shaving preparation suits you—still there may be a better way. If there is you want to know it. So won't you let us prove, on *your* face, how excellent this unique product is? It's up to us to prove our point, you've lost nothing if we fail. Please mail the coupon now.

PALMOLIVE RADIO HOUR—Broadcast every Wednesday night—from 9:30 to 10:30 p. m., eastern time; 8:30 to 9:30 p. m., central time; 7:30 to 8:30 p. m., mountain time; 6:30 to 7:30 p. m., Pacific Coast time—over station WEAF and 39 stations associated with The National Broadcasting Company.

With the new unbreakable Bakelite top. 4240

To add the final touch to shaving luxury, we have created Palmolive After Shaving Talc—especially for men. Doesn't show. Leaves the skin smooth and fresh, and gives that well-groomed look. Try the sample we are sending free with the tube of Shaving Cream. There are new delights here for every man. Clip and mail the coupon now.

7 SHAVES FREE
and a can of Palmolive After Shaving Talc

Simply insert your name and address and mail to Dept. B-1595, Palmolive, 3702 Iron St., Chicago, Ill.

Residents of Wisconsin should address Palmolive, Milwaukee, Wis.

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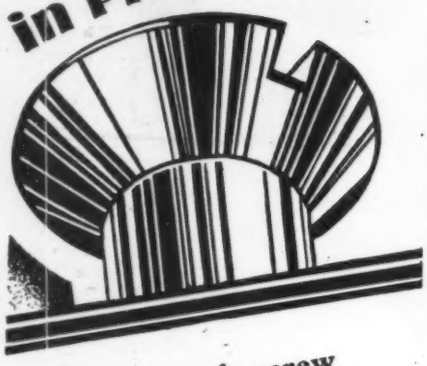

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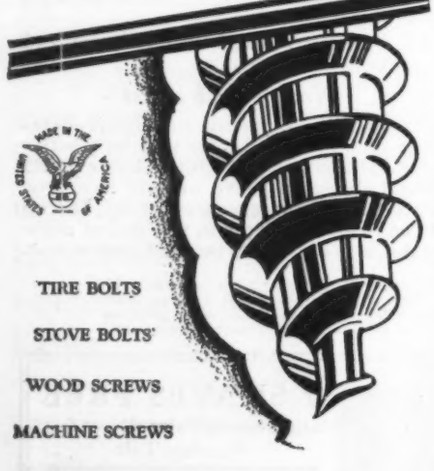

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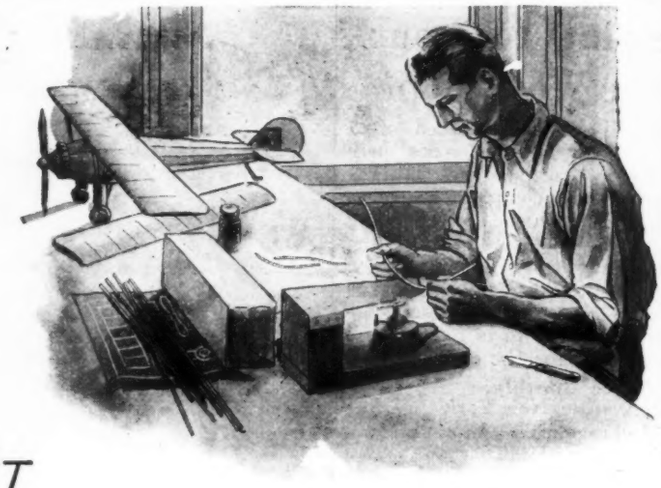


Whittling Model Propellers

Methods Used by Prize Winners in Miniature Aircraft Contests—Bending Bamboo—Other Hints

By A. L. JACKSON

BEGINNERS in airplane model making always wish to know how experts like my little friend Aram Abgarian, who won the Stout Indoor Trophy with a flight of 353.6 seconds, carve the propellers for their record-breaking models.

The first requirement is a good sharp pocketknife. The next is to have suitable material for the blank. In the majority of cases a beginner will use clear, soft white pine unless he is making an especially light model with a framework of balsa wood, in which case the propeller also may be whittled from balsa.

The ideal propeller is of the "true screw" or "true pitch" type; that is, it has a uniform pitch throughout and therefore insures the utmost dynamic thrust and delivers the maximum power.

A long narrow blade is better than a short stubby one. A good ratio for large "props" is six to one in the relation of length to width, although wider propellers are often used with good results, the extreme being represented by a ratio of four to one. Generally speaking, the widest part of the blades should occur about two thirds the length from the hub.

This is the simplest and most effective way I know for a beginner to attain a true screw prop:

Take an oblong blank and square it up on all sides. Assuming it is a right-hand prop desired, draw accurate diagonal lines on both faces of the block (Fig. 1). Where the diagonals cross each other, drill the hole for the propeller shaft.

Next saw or cut away the wood following the face diagonals, but leave an approximate width of ⅛ in. at the hub. The blank will then resemble Fig. 2.

Draw diagonals on the end of the blank as in Fig. 3. They must be exactly opposite from each other on each end; that is, the lines run right-hand from bottom to top on one end and vice versa on the other end.

Hold the propeller blade in your left hand and, starting at the hub, carve away from you. You are really carving to those end diagonals you have drawn. Then, on the same face but in opposite direction (just turn blade around in your hand), carve to the other end diagonal (Fig. 4).

Put a slight "dish" or camber in the blade at this stage. Use fine sandpaper and hollow slightly the *full length* of the blade, but not too deep. After that, carve the other side to conform to the hollow on the front (Fig. 5). Sandpaper the blades down until you can see light showing faintly through them when you hold the prop up to a window. Then, and then only, should you round the tips. A coin may be used as a template for marking the ends.

A special blank is not essential for a toothpick propeller. Just slice off the tip edges of a prop made as described. This will leave a prop with a very narrow pointed blade as in Fig. 7, slightly rounded at the extreme tip. It is a very fast prop and often used on speed models.

The efficiency of the prop varies from nothing at the hub to a maximum at the tips. Weight is an important factor in good flying models; and, since the hub is worthless and offers a hindrance to gliding, cut away as much of it as possible on the front or hollowed side, not the back (Fig. 6). This will not injure the looks of the prop and will reduce its weight and increase the efficiency. However, you must leave at least ⅛ in. in thickness at the hub or you'll break your (*Continued on page 105*)

Whittling Propellers

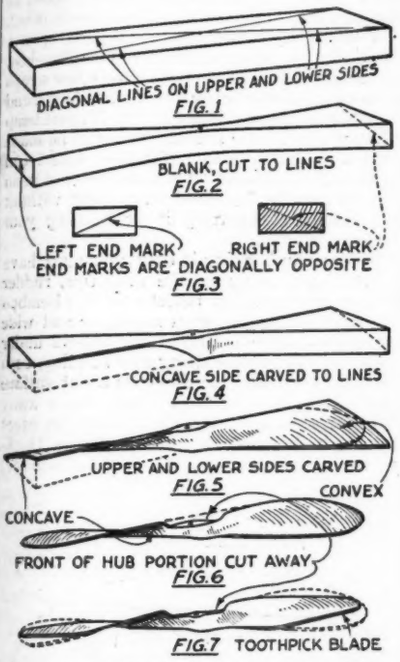
(Continued from page 104)

blade in the process of winding the motor.

Instead of using a pencil to lay out a balsa wood blank, use a metal-edge rule and a knife. Sink the point of the knife into the soft wood for the diagonals on the face of the blank. Be sure to leave the hub wide enough so that it will not break while you are doing the actual carving. You can trim or tear away the wood outside the diagonals and have a straight true edge to carve to throughout the operation.

The propeller shaft is of vital importance. It must be neither too long nor too short and must be absolutely true or it will cause vibration. Use shafts from 1 to 2 in. in length on small models and from 3 to 4 in. on larger props of 8 in. or more.

Pass the shaft through the hub after installing a washer and see that the cut-away portion of the blade is the front. Bend a square U in the end of the shaft as in Fig. 8, assuming you have already bent a rubber hook on the other end. Give this U a wrap or two of silk thread soaked in an ambroid type of cement and pull it back into the hub with the point of the U down and towards the cutting edge of the prop; tap it gently but firmly in place.

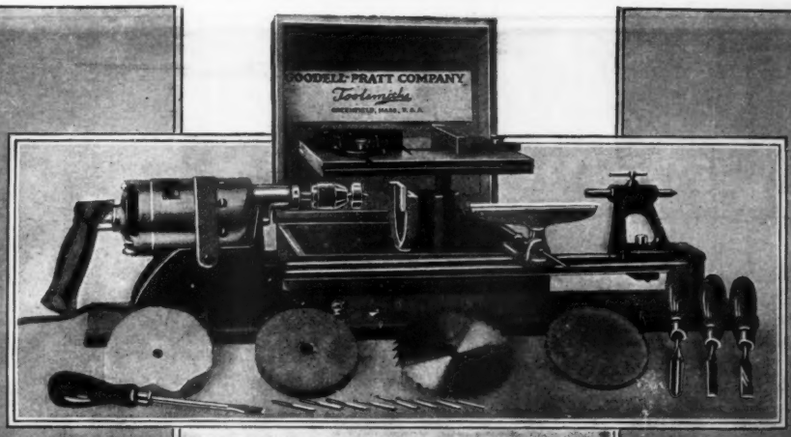


Steps in marking and carving a propeller. Note that the concave faces are the first to be shaped.

A propeller bearing that I find efficient and practical is made from a piece of a cotter pin (Fig. 9). A small pin is used for little models and a larger one for big models. One end of the piece is flattened but not made too thin, and a hole is drilled in it for the propeller shaft. The hole can be made by driving the point of a phonograph needle through it. Cut the piece down as small as practical in length and bend it as shown.

Two things should be remembered: First the only point of contact between the blade and the thrust bearing should be at the hub. If the blade strikes at any other point, the prop will be sluggish in action. Secondly, it is of equal importance to see that the thrust bearing is not too high or low. The motor stick will bend and perhaps break if the bearing is too high, and if it is too low the motor will not clear the stick. The best method to determine the height of a thrust bearing is by experiment.

The precautions just outlined apply also to the rear rubber hook on the opposite end of the motor stick. I (Continued on page 106)



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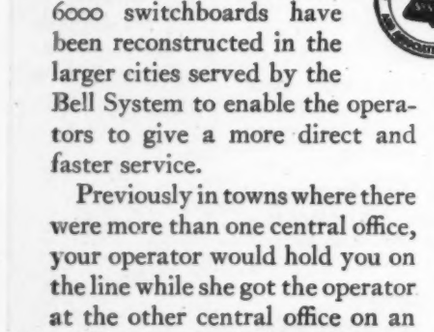

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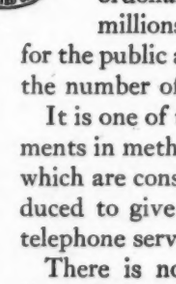

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Whittling Propellers

(*Continued from page 105*)

stretch a thread from the rear hook through the "cans" or motor guides to the thrust bearing at the front. If the thread clears the stick at a sufficient height to allow several strands of rubber to unwind freely, and if it passes directly through the center of the cans and the front thrust bearing, I know that there is little chance for motor trouble to develop.

A new kind of prop that would offer possibilities for the experimenter would be one with a flexible blade portion near the hub to allow an expanding pitch (Fig. 10).

A little known fact about A-frame type models with twin propellers is that the propellers do not have to clear each other. I have flown models with the props overlapping a full half inch. Traveling at the same rate of speed as they do, they seldom crack or touch each other.

While many model makers depend upon a candle for supplying the heat to bend bamboo, a special bender can be made from a few scraps of wood, a piece of fairly heavy sheet brass, and several nails as shown in Fig. 11. A spirit lamp of some sort is also needed. One can be made from a common sewing machine squirt can equipped with a wick. The brass gets hot in an instant and the bamboo can be bent without the danger of charring it or burning your fingers.

Before any bending is done you must have a full size drawing for the wing tips, rudder outlines, and the like. Select a piece of bamboo a few inches longer than necessary and wide enough to make several of the frames under construction. Before doing any bending, turn the bamboo shiny side down on a flat surface and with a knife or razor blade scrape away the soft side until the piece is of the exact thickness desired. Be sure that this thickness is as uniform (*Continued on page 107*)

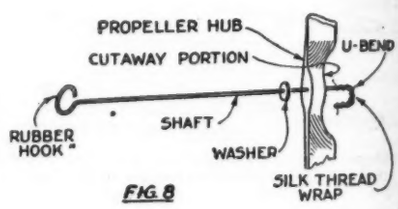

FIG. 8

FIG. 9

FIG. 10

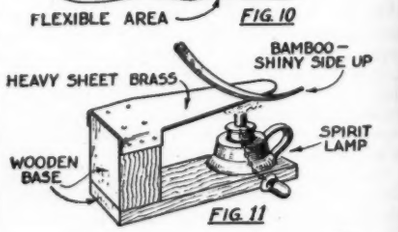

FIG. 11

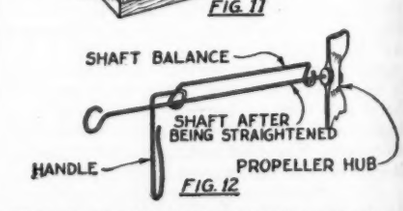

FIG. 12

Methods of making shafts and bearings; a bender for bamboo; and a shaft balancing device.

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Whittling Propellers

(Continued from page 106)

as possible throughout; accuracy is essential.

Hold the bamboo in your fingers, shiny side up, and slide it gently with slight pressure over the hot brass plate. You will be able to feel it give when it is warm enough to be pliable. Sometimes the bamboo will become black on the underside, but if you keep the actual flame from touching it, there is no danger of its burning. After bending to shape, hold the bamboo and blow on it to cool it; then it will retain the contour.

THERE are several methods of splitting it. Perhaps the best is to split it down the exact center and then split the half pieces down their exact centers, continuing until the pieces are reduced to the correct sizes.

A wire propeller balancer made as shown in Fig. 12 is used to straighten a crooked propeller shaft. Place the propeller shaft in the two loops and revolve it. You will be able to detect the slightest bend or irregularity.

Remember that a large amount of undisturbed air passing over a fin or elevator gives the most stability. For that reason a high fin or a wide elevator is to be preferred.

An interesting point in connection with the tiny indoor model described by Bunch and Koch in the November, 1928, issue of POPULAR SCIENCE MONTHLY is that it can be flown also as a "pusher." Turn it around with the rudder to the front, set the wing ahead so that the model will climb, and wind the propeller backward. By putting a left-hand prop on it, the model can qualify for a regular indoor pusher. With an almost identical model William Chaffee added thirteen seconds to the world's record a few years ago.

Choosing a Paint Sprayer

(Continued from page 100)

pressure class, although there are variations between individual guns. The third type using small motors is that in which a gun attachment fits on the blower of a regular household vacuum cleaner. This is a low-pressure gun. As all the motor-driven guns furnish a steady supply of air, an excellent class of work is possible with them. They are convenient and reliable.

The next larger type of gun uses a siphon feed as a rule, but has a one quarter or one half horsepower electric motor with a small air compressor as a separate unit. Because of its greater air supply, such a gun naturally has a greater capacity than the kind just mentioned. It is designed for automobile and furniture finishing and is practical also for interior wood trim and walls of homes.

For painting houses and barns, finishing automobiles and furniture, and for large surfaces generally, spray gun outfits such as *G* are used by professionals. The outfit of this kind shown at the bottom of page 100 has a one-horsepower electric motor and a compressor which delivers seven cubic feet of air a minute at any pressure up to more than 100 lbs. In ordinary operation it is regulated to use about twenty lbs. pressure on the paint supply tank and from thirty to sixty lbs. pressure on the gun to atomize the paint. There are air and paint storage tanks of large capacity, together with air regulating valves and a water and oil separating device, to keep the air stream clean. Either a siphon type of gun or a pressure-feed gun is used with this outfit.

Mr. Vanderwalker, whose books on painting, the use of spray guns, and the like are regarded as standard reference works in the painting trade, will tell how to operate hand and foot pump sprayers and motor-driven spray guns in an article scheduled for early publication. He will explain for beginners how various surfaces should be finished.

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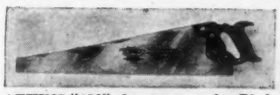

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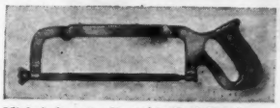

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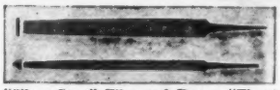

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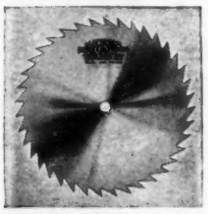

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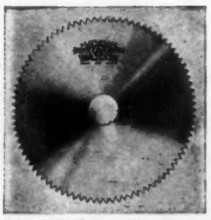

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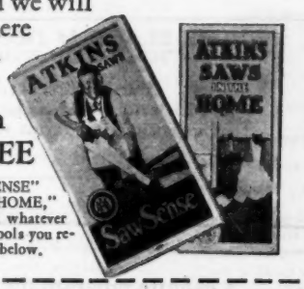

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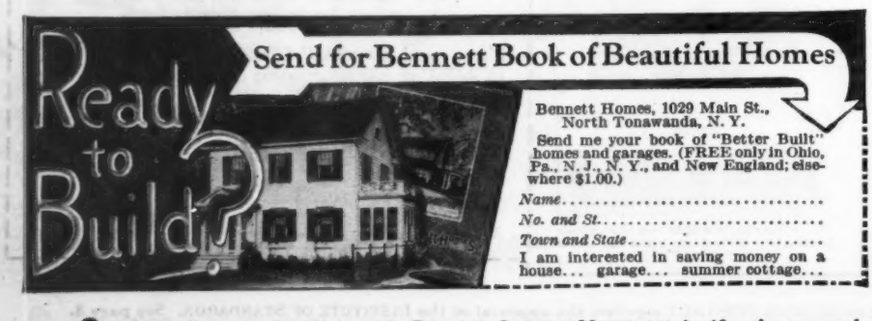
A definite program for getting ahead financially will be found on page four of this issue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Home Workshop Chemistry

Simple Formulas that Will Save Time and Money

THE man who varnishes a piece of furniture or some apparatus which he has just made, or the woman who touches up a chair, is apt to discover certain pertinent facts about varnishes from annoying experience.

Some brands dry too quickly for general use and fail to form a smooth surface. Others require several days for drying, making it impossible for the amateur to produce a clean job without a dust-proof room. Still others dry to a dull, unattractive film or else produce a brittle one which chips easily.

However, the standard Government tests on varnish, most of which the amateur can easily perform, furnish a means of determining accurately the appearance, drying time, and elasticity of the film; and there are special tests for varnishes designed for special purposes. By purchasing only a small sample, or borrowing a few ounces from a neighbor, one can test any brand and often prevent considerable waste in time and money. These tests follow.

Cut a panel about 3 by 5 in. from a clean sheet of tin of a grade weighing about half a pound to the square foot. This is rather light sheet and is specified because it gives a thickness which is ideal for the elasticity test. Hold the panel vertically by one corner, pour a portion of the sample over one side, and allow the excess to drain off. Place the flowed panel in a nearly vertical position in a well-ventilated room, away from the direct rays of the sun, and leave for four hours. At the end of this interval give the so-called "setting to touch test" by lightly touching the film not less than one inch from the edge. The varnish can be considered as passing this test if none of it adheres to the fingers, although it may still be soft. This means that the film is in no more danger of catching lint and dust.

TWENTY-FOUR hours from the time when the varnish was first flowed on, test again by using a firm pressure of the thumb and finger. If the finger does not move the film and leaves no mark which remains noticeable after the spot is lightly polished, the varnish passes the "drying test." Observe the panel carefully in a good light. The film should be smooth, glossy, and free from runs, sags, pits, and other defects.

Leave the panel for another twenty-four hours. At the end of this time, test for elasticity and toughness by placing the tin in water at a temperature of from 70 to 75 degrees (Fahrenheit) for a few minutes; and then, with the film outward, bend it rapidly over a ⅛-in. rod until the panel has been bent double. Examine the film in a good light. A satisfactory varnish, judged *(Continued on page 109)*

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Home Workshop Chemistry

(Continued from page 108)

by United States Government standards, will show no cracking or flaking.

These general tests can be supplemented by several valuable tests for varnishes designed for special purposes. For example, the cold and hot water tests which have been made familiar to the general public in advertisements.

Pour a little of the varnish to be tested on two tin panels and let them dry for forty-eight hours, as described above. Then dip one of the panels into a bowl containing 2½ in. of pure water at room temperature, immersing the end which was uppermost during the drying. Leave for eighteen hours. Ice water is not necessary and, indeed, is not ordinarily used for this test. Remove the panel and dry at room temperature for two hours. The panel must show no whitening and no more than a slight dulling. In the same way, immerse the end of the other panel in 2½ in. of pure boiling water and leave for fifteen minutes. Then remove and dry for two hours. This panel also should show no whitening and no more than a slight dulling.

AN OLD-FASHIONED Navy test for spar varnish, called the "safety of working test," should be of interest to amateur boat builders and other users of exterior varnish. This is designed to determine whether a film will stand a stiff breeze while still wet.

Flow a standard tin panel and immediately place it in the direct draft of a small electric fan (8 or 10 in. across the blades) running at full speed. The panel should be in a nearly but not quite vertical position, approximately 2 ft. from the center of the fan, and set sideways at an angle of 45 degrees to the line of the air current. Leave it in this position for five hours. Then set it aside and allow the varnish to harden overnight under ordinary conditions. The varnish should give a smooth film and appear free from dulling, crow's footing, or frosting.

Probably more floor varnish is used than any other kind, so one of the greatest needs of the amateur brush-wielder is to find a good varnish of this type.

Build a large wooden panel with one side carefully planed and sandpapered and place it just inside the garage or workshop door. It should be of such a size that any one entering must necessarily step upon it. Now mark it into approximately 6-in. strips, each parallel to the door sill. Next borrow or beg from the neighbors as many samples of different kinds of floor varnish as you can find and paint a different strip from each can. The length of the panel will depend on the number of brands to be tested. Keep a record of the brands by number and leave the panel in the doorway for at least a month. Then clean the surface carefully and observe how the different brands have stood the wear and tear of shoe leather. Sometimes this practical and simple test will yield surprising results.—W. H. HAMMOND.

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COLGATE LATHER

Colgate's lather (greatly magnified) showing moisture contact with beard and minimum air. A common-sense principle scientifically authenticated and proved out practically by millions of men.

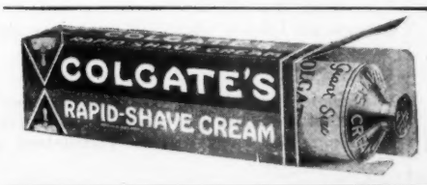
Millions of men prefer Colgate's because they've found—as you will—that as soon as you lather up with Colgate's small-bubble lather, two things happen: 1. The soap in the lather breaks up the oil film that covers each hair. 2. Billions of tiny, moisture-laden bubbles seep down through your beard....crowd around each whisker—soak it soft with water.

Instantly your beard gets moist....easier to cut ....scientifically softened right down at the base ....then your razor can do its best work.

Ordinary big-bubble lathers have more air, less moisture. A comparison will prove Colgate superiority. Note our coupon offer of a week's free trial. We will send also, a sample of After Shave, a new lotion—refreshing, delightful—the perfect shave finale.

ORDINARY LATHER

Ordinary, big-bubble lather (greatly magnified). Note air-filled bubbles which can't soften the beard efficiently. Only water can do the job. Only small bubbles permit sufficient water.



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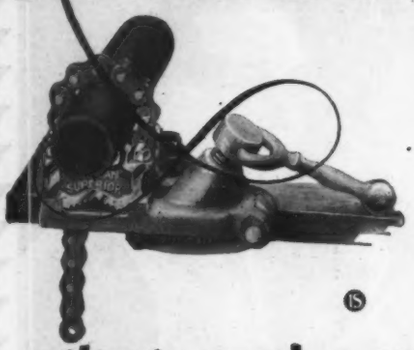

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1. Overhead Adjustment—the handle is ON TOP where it's easy to operate.
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No. 11, for ⅛ to 2½" pipe
No. 12, for ¼ to 4½" pipe

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WILLIAMS
"VULCAN"
SUPERIOR
CHAIN PIPE VISE

Upholstering Old Chairs

(*Continued from page 102*)

A good layer of sheet cotton must be spread over the cloth which covers the filling, and all irregularities filled out with cotton. Then the upholstering material is stretched over this and tacked underneath.

All upholstering over springs is done in a similar manner. In many cases the bar and spring method is replaced by webbing and springs, the webbing being tacked to the underside of the framework, as shown in Fig. 5. Coil springs are sewn to the crosses, then tied as before. The bar and spring method is more durable and should be used when possible.

In many old pieces where the wood has been badly weakened by tack holes, the webbing is replaced by bars and springs. As each bar is suspended from the top of the frame, it is not likely to give way.

Springs should be used with webbing only where the seat frame is of the apron type and forms a box in which to set the springs. At the left of Fig. 5 is illustrated the flat type of seat, in which burlap should be tacked directly over the webbing, then the seat filling applied, and the upholstering completed as described.

At the right of Fig. 5 is shown another and more economical, only not quite so comfortable, a way of renewing worn-out seats. In this instance a board of suitable size and thickness is nailed or screwed to the underside of the seat, then filled and upholstered as just suggested. The dotted line shows the edges of the board.

Fig. 5. Whether webbing or a thin board is used to make a foundation for upholstery on a flat seat frame, it is applied on the underside.

Figure 5 represents excellent ways of renewing cane, splint, or rush seats. Anyone can make this type of upholstered seat, but it is almost impossible to find a man who can or will renew the seats as they originally were.

Any of the materials whose use is recommended here may be obtained from upholsterers and repair men, as, ordinarily, they carry them in stock. Pieces of upholstery materials may also be found at the same places. Many upholsterers stock a goodly supply of samples and remnants of tapestry, velvets, velours, mohairs, plushes, imitation leather, and other materials. These are kept for sale and may be had for from one twentieth to one quarter of the regular price a yard.

There is one kind of upholstering which no one should ever try to duplicate; and when a piece which has this kind of upholstery on it is gone over, it should be changed to plain filling. The kind I refer to is called "biscuit tufting"; it consists of wads of tow or other filling with the covering drawn down between the wads with buttons. This method not only catches dirt and dust, but it holds all it catches.

Upholstering, as such, is actually a trade in itself; for those who have had no experience at all, a visit to some repair shop might prove of value. Repair men as a rule are genial fellows. They are usually willing to show others how to do anything they can do themselves. I have found it a pleasure to show a number of persons all I knew about different jobs they wanted to do themselves.

This is the eighth in Mr. Stanley's series of articles on restoring old furniture. The next will be published in an early issue.

Stands Over the Under-Producer

Stands Up for the HIGH Producer—

Veeder-ROOT HEAVY DUTY PRESS COUNTER

This new Press Counter will keep watch of the workman who's apt to lag and let his production sag. It will keep his record in front of him, and keep his mind on his task. It will make him responsible for a better showing. Subject to check-up at any minute.

Your industrious worker will show his speed as never before, when it registers on a Counter. It will prove his value, protect his job. He'll be sure he's paid for all he earns. You'll be sure you get all you pay for.

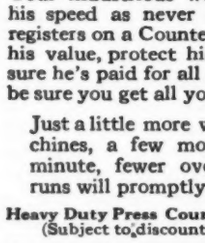
Just a little more work from machines, a few more pieces per minute, fewer over- or under-runs will promptly pay for these

Heavy Duty Press Counters at $6.50 each
(Subject to discount on quantities)

Ask for special circular with full particulars about Press Counters.

Small Counters

This small Rotary Ratchet Counter (No.6) counts reciprocating movements of the lever, as required for recording the output or operations of small machines. When the lever is moved through an angle of 40 to 60 degrees, the counter registers one. The farther the lever is moved, the higher the number registered. A complete revolution of the lever registers ten. This counter can be adapted to no end of counting purposes, by regulating the throw of the lever. Price $2.00. (*Cut nearly full size.*) Small *Revolution* Counter, also $2.00.



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Ping-Pong Table

(Continued from page 77)

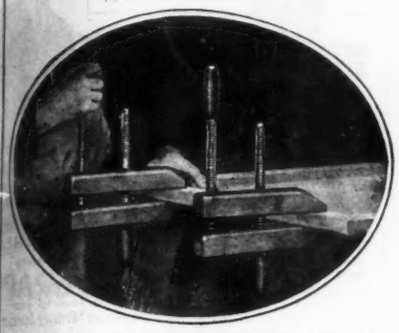

Fig. 3. Hand screws are used to clamp the reinforcing pieces to each section of the top.

the end pieces of the two sections which are to receive within their recesses the square ends of the disassembled side rails, place ⅜-in. dowels as indicated in Fig. 2, underside view. The dowels are to hold the rails in place while the board is doing duty as a screen.

Cut crosspieces to fit between the long sides of each section. Those for the two middle sections should be cut down to ⅜ in. in thickness for 10 in. from one end to allow the side rails to be fitted there, as in Fig. 2. Fasten all joints (except at the cut-down ends just mentioned) with ½-in. corrugated fasteners.

Plane the edges of each section. Bevel them a very little toward the underside to insure perfect contact between the sections on the playing surface of the board.

In order to make adjoining sections flush at the joint, place five 2 in. wide brass or steel butts on the back of the two outside joints—that is, the joints between leaves one and two and between three and four. To place these, lay two joining sections face down on a flat surface and hold them in perfect contact while all the screws are driven home.

Turn the pairs of sections right side up, bring them together for the middle joint, hold them in perfect contact, and put five hinges in place on the top of the board. The plates of these hinges may be set in flush if desired, but they will come under the net out of the way of the game. Place rubber domes—rubber tipped nails—to protect both the ends of the sections and the floor when the board is used as a screen. All parts of the board itself are now in place.

To finish the table complete in itself, prepare four legs of the dimensions given, preferably of oak or other hardwood. Place them 8 in. from the ends of the top and fasten them with 3 in. wide steel or brass hinges, as in Figs. 2 and 4. See that the entire barrel or round part on the hinge is on the leg. Use 1-in. screws.

Obtain eight hooks at least 17 in. long and sixteen heavy screw eyes, say of ⅜-in. wire or No. 5 American wire gage. Attach four of the hooks with the screw eyes to the inner faces of the legs as shown in the end view of Fig. 2. Raise the legs until they stand perpendicularly, then locate and place the four eyes in the underside of the (Continued on page 112)

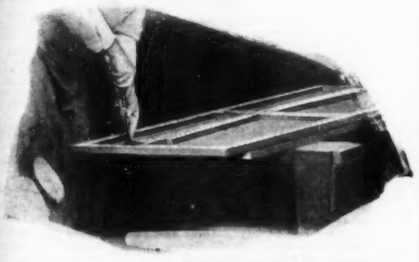

Fig. 4. Mr. King demonstrates how the legs are hinged to the reinforcing strips of the top.

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THAT'S how a New York rider compares his Harley-Davidson to an airplane. And he's right!

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It pays to keep a supply of Simonds Hack Saw Blades on hand at all times. They form an important part of every well-equipped workshop. The keenest judge of tool quality—the experienced craftsman who knows the finest cutting tools—will tell you that for real economy and satisfaction it pays to use Simonds. Ask your dealer.

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BRANCH OFFICES AND SERVICE SHOPS IN PRINCIPAL CITIES

Ping-Pong Table

(*Continued from page 111*)

top as shown in the same view. Ignore the other four hooks for the time being.

Get out four rails ⅞ by 4¾ by 55½ in. long. These are made ¼ in. wider than the corresponding notch (marked *A*, Fig. 2) of the legs to which they are related; the extra width is to allow for the space left by the hinges of the legs. Slight planing in width, however, may be required.

Make the splice joints as shown in Fig. 5. Verify all dimensions before making these joints to insure that the ends of the rails will be flush with the outside of the legs. Prepare four cleats ¾ by 1¼ by 4¾ in. and fasten them to the rails as shown in Fig. 5 with glue

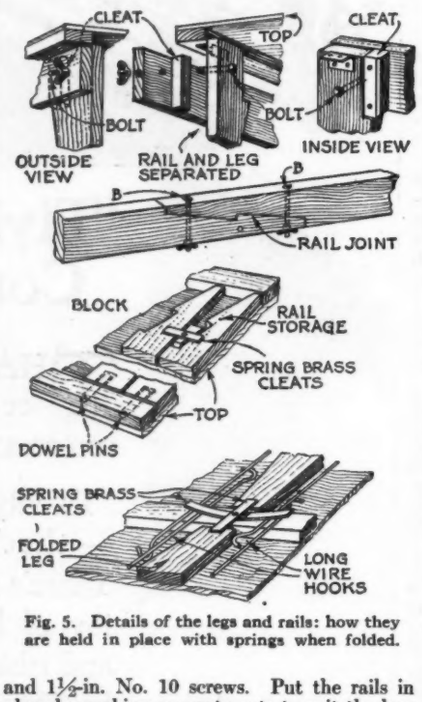

Fig. 5. Details of the legs and rails: how they are held in place with springs when folded.

and 1½-in. No. 10 screws. Put the rails in place by making accurate cuts to suit the legs and joints. There should be perfect contact between the rails and the underside of the table top throughout the entire length of the rails.

Bore ⅝-in. holes through each spliced joint as at *B*, Fig. 5, to receive ¼-by-5-in. carriage bolts. The heads of the bolts must be sunk into the top edge of the rails. Also bore holes through both rails and legs as shown to receive ¼-by-2½-in. bolts.

Now fit the remaining four screw eyes to the legs and drive the corresponding screw eyes in the under edges of the rails as in the side view of Fig. 2. Bore holes in the end of each rail to drop over the dowels which help to hold them in place when the table is folded. Fit springs to hold the legs and the rails after gluing and bradding small pieces of wood to the underside of the top where necessary to receive the springs.

Cut notches across the middle pieces of the end sections to receive the hooks and place springs to hold them there.

If the outside sections are ever folded far back, it may be necessary to cut the cross-pieces of the middle sections away at *C* to receive the springs. Should the leg hinges bruise the wood at *D*, cut away the wood neatly. A cloth pocket to receive the bolts may be tacked and glued in place as shown in Fig. 2.

Get out two net posts ⅞ by 2½ by 12½ in. and place two screw eyes in each to receive the net strings. Fit each post over the edge of the table and (*Continued on page 118*)

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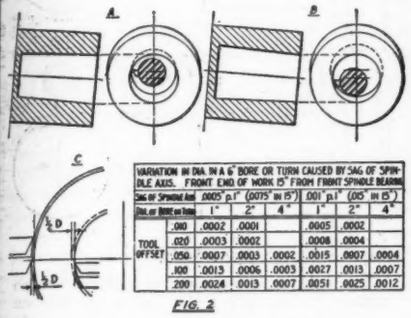
Turning Oversize Work

(Continued from page 86)

will often be all that is necessary. As has been shown, the bore will be concentric, though tapering, so that the reamed hole will be in line. The right reamer is not always available, however; besides, it cannot always be applied. Therefore it will pay to remember that by having the tool very nearly central in taking the finishing cuts, we will be able to produce a turn or bore which will be very nearly right, in spite of the sag in the axis.

The table at *C* in Fig. 2 will give an idea of how near the center it is necessary to set the point—or the center of the grinder spindle—to get accurate results. Usually the best way will be to set the tool as near dead center—true theoretical spindle center—as possible;



VARIATION IN DIA. IN A 6" BORE OR TURN CAUSED BY SAG OF SPINDLE AXIS. FRONT END OF WORK 15" FROM FRONT SPINDLE BEARING

Sag of Spindle Axis	.0005" p.i" (.0075" in 15")			.001" p.i" (.015" in 15")		
Dia. of Bore or Turn	1"	2"	4"	1"	2"	4"
TOOL OFFSET .010	.0002	.0001		.0005	.0002	
TOOL OFFSET .020	.0003	.0002		.0008	.0004	
TOOL OFFSET .050	.0007	.0003	.0002	.0015	.0007	.0004
TOOL OFFSET .100	.0013	.0006	.0003	.0027	.0013	.0007
TOOL OFFSET .200	.0024	.0013	.0007	.0051	.0025	.0012

FIG. 2

When work is so heavy it sags, set the tool as nearly central as possible for the finishing cuts.

for, although the entire axis of the work is below this line, the rotation of the work has a tendency to throw the point of the tool down and thus even up matters.

Every effort should also be made to prevent sag in the spindle. Sometimes the situation can be bettered considerably by mounting the work on the faceplate instead of holding it in the chuck, as may be seen from Fig. 3. The heavy four-jaw chuck at *A* sets the work out much farther from the spindle bearing and adds, besides, a heavy weight of its own just where it is not wanted. By substituting the faceplate as at *B*, the weight and its effective leverage on the spindle may be reduced to half and less in many cases. Not only will the likelihood of error be lessened in this manner, but the spindle will often be saved from undue strain.

In some other cases, the steady-rest may be called in to help. Where the work is not otherwise of a shape that will offer a hold, a "stub" or extension may sometimes be cast on for this purpose and turned off as a last operation. Merely supporting the work in this manner, however, (Continued on page 114)

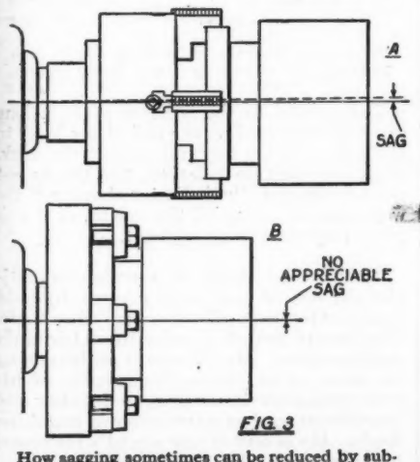


FIG. 3

How sagging sometimes can be reduced by substituting a faceplate for a heavy four-jaw chuck.

TORTURED by constant pressure, your brakes—or rather brake linings—tend to become "metalled over"—and when this happens, they squeal.

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Turning Oversize Work

(*Continued from page 113*)

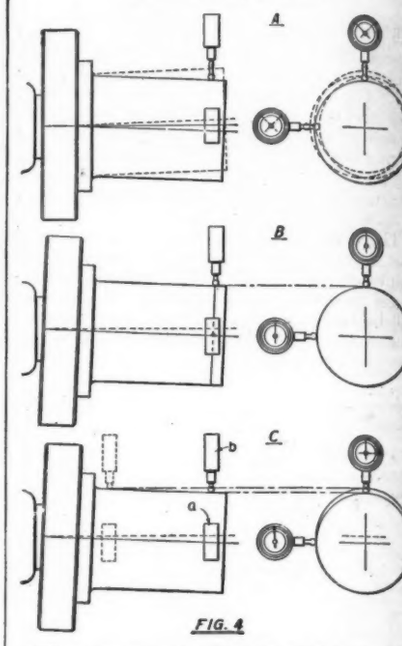

FIG. 4

When you suspect a piece is sagging, run an indicator along either the top or the bottom.

does not do away with the disalignment. Since the spindle sags the moment the work is in place and it is usually difficult to determine the exact amount of sag, there should be some means that will automatically bring the spindle back to alignment.

Figure 1 shows a simple way to solve this problem. The supporting end *a* is first turned to the proper diameter. The spindle is then stopped, a scantling *b* placed across the front vee and under the work, and the end weighted down so it will approximately counterbalance the weight of the work—and of the chuck, if one is used. The lever should take hold about under the center of the work, which in the present case is accomplished by nailing a small block on top of the scantling. Where the work is too large in diameter, the scantling may be placed below the bed and across a sawbuck

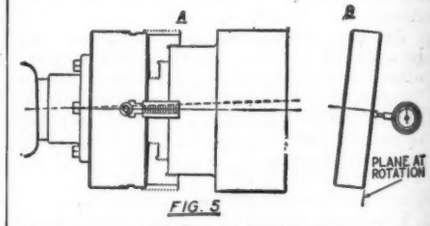

FIG. 5

Diagram to illustrate the bending moment in a lathe spindle caused by a very heavy casting.

placed parallel to the lathe as at *B*, a long block *a* being used on the end of the lever to reach through the gap and support the work. With the work so balanced, the steady-rest can be adjusted, the indicator showing if the work sags on easing off the weight, or if it is pushed up while being adjusted.

This is the third of a series of articles on easier and better ways to hold work on lathes and other machine tools. The fourth article is scheduled for early publication. Mr. Simon is endeavoring to sum up in them the results of his own long experience as a toolmaker and machinist and as a designer of machine tools. He is one of the world's foremost writers on machine shop problems.

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Timesavers for Shop Men

(*Continued from page 94*)

more than is necessary. The completed holder can be turned to fit the device in which it will be used. The dimensions given in the cut are for the average diamond, which will be about 3/16 in. across, and, of course, can be changed to suit the size of diamond to be mounted.

—HECTOR J. CHAMBERLAND.

IN USING parallels under flat work that has to be milled or ground, considerable difficulty is often encountered either because the parallels tip when the vise is tightened or because they are subsequently jarred loose under the action of the cutter or wheel. The result is only too often spoiled and damaged work.

By spending a few odd minutes to make some spreaders in the shape of thin leaf springs like those illustrated at the top of the third column on page 94, trouble from this source can be avoided. Several spreaders of different width and degree of curvature should be made to take care of work of varying width and height. By making the spreaders of spring brass or bronze, the danger of damage to a milling cutter which might come in contact with them is avoided.

Though it is not necessary to use the "button" shown in the drawing, it is advisable to have it where it is possible to provide the parallels with a small hole through the center. An easy way to obtain the button is to cut a round-headed screw or rivet off just slightly below the head and rivet or solder it in place.

A spreader of this kind is rarely if ever in the way and is almost always a great improvement over using unsupported parallels. The spreaders will also be found useful where a special device, such as a "spider," is not at hand when lining up short work in the lathe chuck, and it is necessary to resort to parallels.

THERE are various devices for gaging the points of drills. The writer previously contributed a gage that shows the concentricity of the point and derives its particular usefulness from the fact that the correct location of the point goes a long ways towards insuring the correctness of the cutting angle. On the principle that we usually think of the simplest thing last, the writer now offers a gage which, besides verifying the drill size, at once shows the concentricity of the point, the truth of the cutting angle, and the clearance.

This truly universal gage is a little more work to make than other devices, but, even so, it is simplicity itself, and the combination of advantages it offers will recommend it.

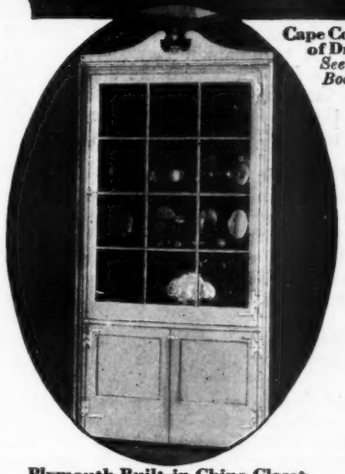
As will be seen from the lower right-hand illustration on page 94, a row of holes is carefully drilled in line in a piece of flat stock; then one half of the stock is milled away over the ends of the holes to expose the cross section. Every element entering into the point design then can be checked at once.

The gage can be made from 3 to 4 in. long, the width and thickness being controlled by the size of the drills. The particular gage shown is 3½ in. long, ⅝ in. thick, and 1¼ in. wide, and accommodates drills from ¼ to 13/32 in. inclusive by thirty-seconds. For small drills, as many as a dozen and a half sizes can be accommodated in a gage of similar length.

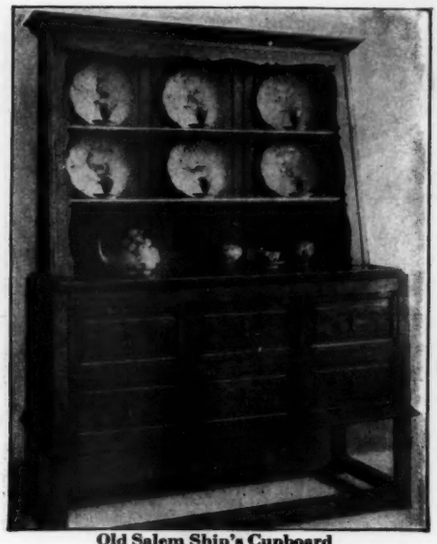
The main things to watch are getting the holes all in line and straight, and finishing each hole with a drill freshly ground exactly to the right shape. While it is not necessary to have the gage hard, it will pay to make it of non-shrinking tool steel and heat treat it; this will also give it the desirable dark color.

At *A* is shown a drill slightly off on one cutting lip. From the same view it will be plain how the clearance may be ascertained by turning the drill slowly to the right. If the space between the lip surface and the edge *A* of the gage steadily increases as the drill is turned, the amount of clearance is plainly seen, as are also any spots on the lip surface that are too high or too low.—HENRY SIMON.

Cape Cod Chest of Drawers
See LePage's Book, page 3



Plymouth Built-in China Closet
See LePage's Book, page 6



Old Salem Ship's Cupboard
See LePage's Book, page 5

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26 Spanish Galleon
27 Vanity Table

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Turning Rings of Wood

(Continued from page 79)

edge. Alternate with a ½-in. skew chisel, which should be held so that it cuts with the toe (see Fig. 3, page 114, Oct., 1928, issue). Test the diameter of the hole with a pair of inside calipers. Then round the edges and sandpaper the work.

The dead center should now be moved up again, so that its point bears against the wood at the bottom of the hole just cut. This added support is needed for cutting the first napkin ring away with the parting tool. The remaining one is then bored and cut off in the same manner.

The remaining end of the 6-in. piece is now turned until it is equal to the diameter of the holes which have just been cut halfway through the two napkin rings. The length should be a little less than the depth of the hole, so that the napkin rings will butt up against the square shoulder formed on the piece as in Fig. 2.

WHILE turning this chuck, try the fit of both napkin rings frequently, because the hole cut in one napkin ring is likely to be slightly larger than the hole cut in the other. Finish the larger one first and then cut down the chuck to fit the smaller one. Do not force the rings too tightly on the chuck or they may split.

Bore the other half of the hole in each ring as explained above. Then stain and polish the rings.

When a ring having a circular cross section is to be turned from a solid piece of wood, the stock, after being faced off, should have the same thickness as the diameter of the cross section of the ring, as indicated in Fig. 4. A piece of ¼-in. plywood is placed between the screw chuck and the material to be turned and prevents the screw in the chuck from penetrating the ¾-in. disk.

After facing off the disk and turning it to the required outside diameter—in this case ⅄ in.—it is cut down as shown in Fig. 4. The square corners are then cut off (Fig. 5), after which the ring is rounded as shown in Fig. 6.

A template may be made of a piece of strong cardboard or veneer about 2 in. square. Proceed as follows: Draw a straight pencil line about in the center of the piece of cardboard. Tack it to a piece of wood, place the screw of an auger bit of the desired diameter—in this case ¾ in.—on the center line, and bore a hole. Cut on the line with a knife, thus dividing the cardboard in two pieces. Use half of it as a template (Fig. 7).

CHUCK the partly turned ring as shown in Fig. 6. The wood used in making the chuck may be soft, and it is well to have it thick in case the recess cut in it should be too large; in that case it may be faced off again and another recess cut. The center is now cut away and the turning of the ring completed.

Such rings may be used for the hanging of curtains or portieres, or as towel or necktie rings. A necktie holder is shown in Fig. 8. It fits into another turned piece, which is screwed to the wall or to a closet door.

A small section is cut out of the ring, thus permitting it to be sprung a little and slipped into a hole bored in each side of the turned piece. The center of these holes is found by wrapping a strip of paper ⅞ in. wide around the piece. Cut the ends of the paper so that they just meet. Remove the paper and fold it once in the center. Draw a pencil line lengthwise through the center of the paper, wrap it again around the wood, and prick a hole on the center line where the ends of the paper meet and another where the pencil line crosses the fold (Fig. 9). Bore these holes while the turned piece is in the lathe and before the ends have been cut off.

A towel ring *(Continued on page 118)*

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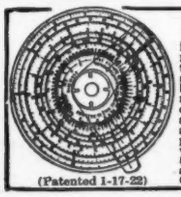

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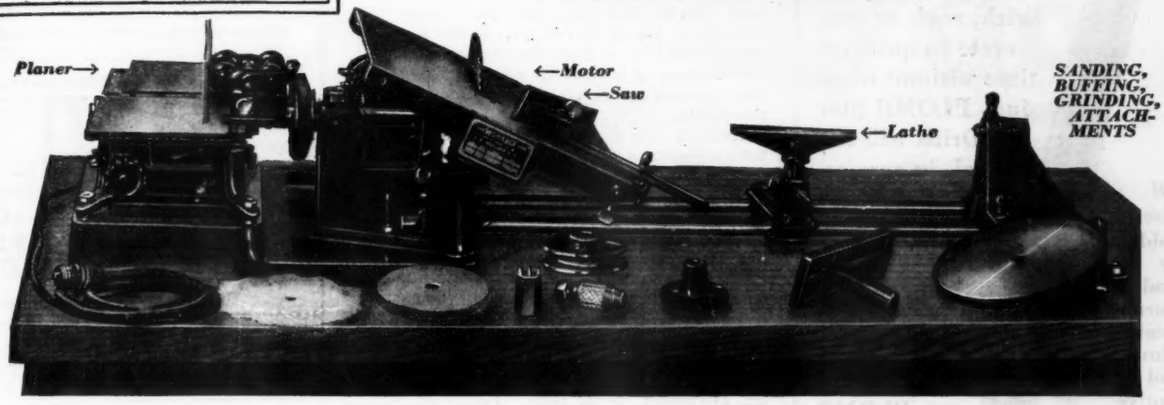

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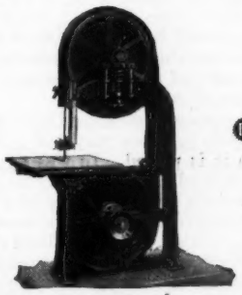

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Turning Rings of Wood

(Continued from page 116)

should be a little larger. It may be flattened slightly on one side and fastened at right angles to a wall or a door with a round-head screw (Fig. 10).

These rings may be made stronger and more interesting if they are made of three or more layers of wood, preferably of contrasting colors, such as walnut and birch. Thin layers of ebonized wood about 1/16 in. thick will appear as black inlaid lines. The layers should always be an uneven number. If three are used, the inside layer should run at right angles to the two outside layers (see the section in Fig. 10). It is obvious that the layers should be glued up into a solid block or disk before the ring is turned.

THE turned picture or mirror frame is simply another type of ring. Make a full size drawing of the frame and screw a piece of wood of the required dimensions to a small faceplate. Face off and turn the piece to the desired diameter. Cut the recess for the picture, glass, and backing as shown in Fig. 11. If the frame is going to be thinner than the one shown, it will be necessary to back it up with a piece of plywood as shown in Fig. 4 to prevent cutting into the screws.

Remove the disk from the faceplate and turn a chuck as shown in Fig. 12. The disk is now fitted to the chuck, its center cut away, and the design of the molding turned.

Some wood turners prefer first to turn and polish the face of the frame, then to chuck it, and finally to cut the recess for the glass. The method described above permits the molding to be finished and polished after all the cutting has been done and prevents it from being marred by chucking.

Other designs for picture frame moldings are shown in an article by Mr. Klenke on page 82, December, 1928, issue. Books on wood turning having many attractive designs may also be consulted in most public libraries. The following are to be recommended: *Course in Wood Turning*, Milton and Wohlers; *Art and Education in Wood-Turning*, William W. Klenke; *Wood Turning*, George A. Ross.

To obtain the best results, a close grained wood such as birch, maple, mahogany, or walnut should be used for projects of the kind described in this article. Directions for finishing turned articles were given on pages 132 and 133 of the October, 1928, issue.

Mr. Hjorth's next article will deal with the turning of boxes, trays, and bowls.

Ping-Pong Table

(Continued from page 112)

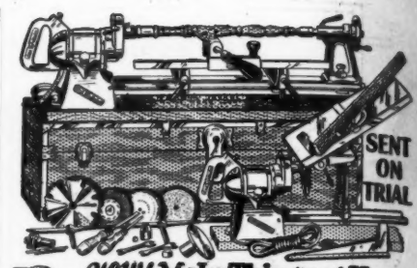
bore a 5/16-in. hole through each post and the table rail to receive a 2½-in. carriage bolt.

To finish the table, fill the nail holes in the top with plastic wood cement or other putty suitable for bare wood. Then stain the wood brown to match the pressed wood, if that has been used, or dark green, if that color is preferred and if a wall board of lighter color forms the surface of the board. Give the legs and rails two coats of shellac or varnish and the top the same, if desired.

When the ping-pong board is used as a screen, the mass of brown or green may not suit the room in which it is placed. In this case instead of being stained, the board may be decorated in modernistic style or in any way preferred, or a decorative textile may be used.

Green denim or other cloth, or billiard cloth, may be used to cover the table for games. It should be cut to fit around the net posts and allowed to fall over the edge, or it may be held in place with snaps.

Ping-pong sets containing rackets, balls, net, and the like, may be purchased at almost any store dealing in sporting goods.



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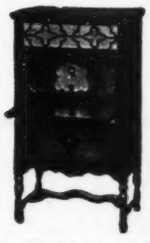
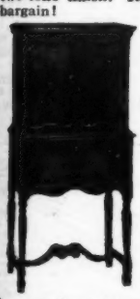
Richly designed, genuine walnut console of finest type. Electro-dynamic or magnetic power cone, or long air column speaker. Marvelous value.



A popular walnut Hi-Boy Console, with drop-leaf desk. Beautiful two-tone finish. Rare bargain!



Beautifully graceful Spinet console, genuine two-tone walnut. Choice of speakers. Also comes in Electric Phonograph-Radio Combination.

A new-type arm-chair console. Genuine walnut. Very pretty. Low priced. Electro-Dynamic or Magnetic-Power Speakers.

At right, a Lo-Boy console, walnut finish, that costs little. A gem!

Above, popular inexpensive combination. Set on Table Speaker (sold separately).

Metal or wood compact style cabinets. Wood cabinets in walnut or new shaded silverchrome finishes. Cathedral Electro-Dynamic or Magnetic-Power Speaker to match!

This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

No other Hammers like MAYDOLE

Built with as much care as the finest precision tools, Maydole Hammers have been the choice of skilled American craftsmen for more than 85 years.

The heads are press-forged from the finest tool steel obtainable and the handles are carefully shaped from clear, second growth hickory that has been thoroughly seasoned and put into the heads "for keeps." Every one has that remarkable Maydole "hang."

Driving or pulling, there's more in a Maydole than in any ordinary hammer. Your hardware dealer carries a complete stock, ask him to show you the style and weight you prefer. Write for a free copy of Pocket Handbook 23 "B."

YOUR HAMMER SINCE 1843

Maydole Hammers

The David Maydole Hammer Co. Norwich, N.Y.

2468

Model Railway Control

(*Continued from page 78*)

train from going too fast and being wrecked.

The double-pole switch is wired as shown in Fig. 5. Check this wiring and you will find that when the switch is thrown to one side, the full voltage is supplied to one grade, and the voltage to the other grade is reduced by a rheostat that can be adjusted for down-grade running. This rheostat is shown on the control panel just below the double-throw switch. A train running around the track strikes the up-grade and receives the full voltage while it is climbing. When it strikes the down-grade, the voltage is automatically reduced.

You do not have to make any hand adjustments on account of the grades, even if two or more trains are running on the track at the same time. Of course, if one train is faster than the other, you will have to stop the faster train at intervals to prevent it from overtaking the slower train. But if your railroad is equipped with an automatic block system such as was described in the December, 1926, issue of POPULAR SCIENCE MONTHLY, page 70, the trains will require no attention whatever.

THE double-throw switch is provided so that you can reverse the voltage control to the grades when you desire to operate a train in the opposite direction.

The voltage changing switch on a small transformer necessarily must be made so that the current will be cut off between switch points. The automatic reversing locomotives are of the sequence reversing type. Each time you cut off the current and turn it on again the locomotive starts in the opposite direction. Therefore you cannot change the voltage while the train is running unless you stop and start it all over again. This is rather awkward when you want to increase the voltage to take care of an additional train.

There is, however, a way to overcome this difficulty, and the remaining switch on the control board accomplishes this result. Near the lower right-hand corner (Fig. 3) you will note a small lever projecting through the board. This is a standard type two-way electric light switch of the toggle variety. The usual metal plate has been left off because it would spoil the appearance of the board.

The wiring is shown in Fig. 4. In one position current for the track is obtained from one transformer terminal, and in the other position current is obtained from a higher voltage tap. The secret of this switch is that it snaps from one position to the other so rapidly that the reversing mechanism in the locomotive has no time to operate and the train continues in the same direction with no apparent break.

This switch, plus the rheostats for minor variations, will permit you to obtain a wide range of control. Figure 2 shows the underside of the control panel. Ordinary bell wire is used throughout.

As supplied by the manufacturer, each electrically controlled switch has a three-wire cable leading to it from a flat type two-way switch. The white threaded (*Continued on page 121*)

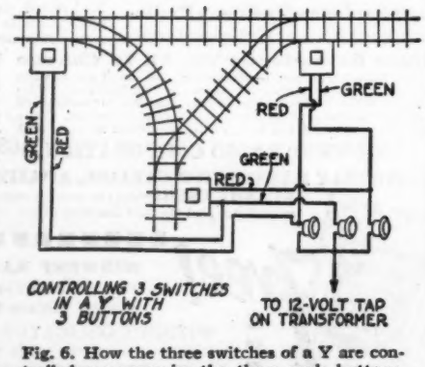


Fig. 6. How the three switches of a Y are controlled as a group by the three push buttons.

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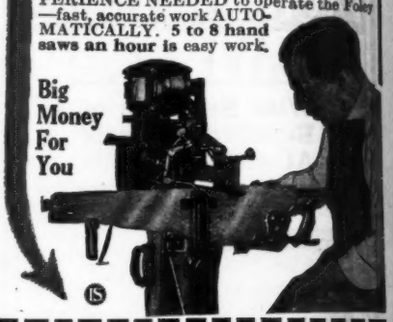

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EASY TERMS 30 DAYS TRIAL QUICKLY PAYS FOR ITSELF

HOBART BROS. CO. Box P291, Troy, Ohio

Model Railway Control

(*Continued from page 120*)

wire of the three connects the arm of the switch to the third rail. The green and red threaded wires connect the contacts of the switch with one end of each electromagnet, the other wire from each electromagnet being grounded on the running rails of the switch.

In wiring the switches for push-button control, you may disregard the white threaded wire and extend only the green and red threaded wires to the control board. The wire that supplies current from the transformer to the third rail by way of the toggle switches can also be connected to one side of each of the switch control buttons. The remaining terminals of these buttons can be connected to the red and green wires from the switches.

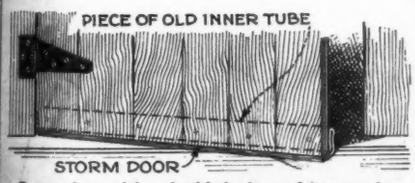
IF YOU install independent control for each switch, you will need two buttons for each switch, but a group control will save buttons and prevent mistakes in operation. The proper grouping of the switches will depend on your track layout, and a little study will be required to determine the best arrangement.

As an example of what may be done in this direction, examine Fig. 6, which shows in picture diagram form the simplest connections for a Y. One button is connected to the green wires from the two switches on the main line. The second button is connected with the red wire from the left-hand main line switch and the green wire from the Y switch. The third button applies current to the red wires from the Y and right-hand main line switches.

Pressing the first button clears the main line, no matter how the switches were set before the button was pressed. A touch on the second button sets the switches for a train going out to the left or coming from that direction. The third button allows trains to travel over the Y to the right.

Similarly, two buttons will control the two switches that are used in a crossover; and in the terminal you can provide one button for throwing all the switches to clear the track to the last siding and have individual buttons for controlling the other positions of the switches along the track that lead into sidings nearer the main line.

Weatherstrip for Bottom of Storm Door



Storm door with a doubled piece of inner tube applied to keep it weather-tight at the bottom.

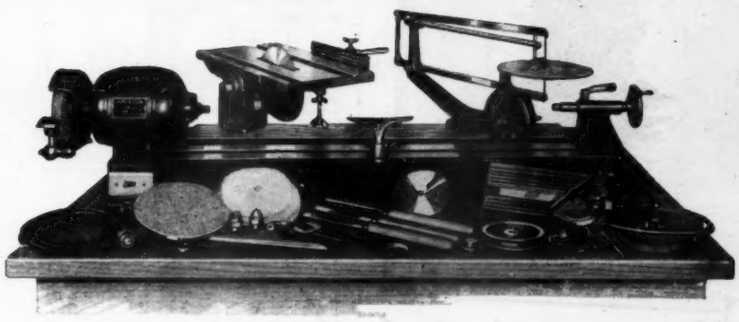
HINGED weatherstrip with a rubber edge, such as is often fastened at the bottom of a storm door, is apt to be more ornamental than effective, but a weatherstrip may be made of an old inner tube that will accomplish all that can be desired in keeping out wind, rain, and snow.

Be sure the bottom of the door clears the threshold by ½ or ¾ in. Prepare a piece of board 4½ or 5 in. wide and the width of the door opening in length, to be used as a pattern. Cut a piece of old inner tube lengthwise and spread it open, flat and straight, upon a board; fasten it lightly with tacks, without stretching. Lay the pattern upon the tube and with a sharp knife cut accurately around the board.

Fold the rubber lengthwise in the middle and touch it lightly with cement an inch or two each side of the fold, but not near the edges, to hold it together while it is being tacked to the inside of the door.—C. A. K.

THE KING OF THEM ALL

AR-CON UTILITOOL



It Won Instant Acclaim from Those Who *Know!*

Conclusive proof that thousands of professional and amateur artisans throughout the country were waiting for just such a sturdy, powerful, quality-built workshop as the Ar-Con Utilitool, lies in the uniformly high character of the inquiries which have inundated us since its announcement, and in the countless enthusiastic commendations of men who *know* tools.

Here is the testimony of experts who know from experience what they want, and who in many cases have told us of their eagerness to dispose of present equipment in order to replace it with the Ar-Con Utilitool. They recognize, for instance, the outstanding superiority of its ½ H.P., ball-bearing, repulsion-induction type motor—a more costly type to build, of course, but also more efficient, with its abundance of reserve power and greater freedom from trouble. And they recognize the same high standards of design and construction, the same ideals of quality translated into terms of strength and accuracy, in every unit and accessory of this new and better workshop.

In short, Ar-Con Utilitool is not a plaything to tire of when limitations are revealed; it is a dependable, efficient outfit that is a never-ending source of delightful, constructive recreation—and, if you wish, of profit as well.

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THE AR-CON TOOL COMPANY

500 Fassett Street - Toledo, Ohio

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500 Fassett Street, Toledo, Ohio

Mail descriptive circular on Ar-Con Utilitool, with prices and terms.

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Street Address .....

City and State .....

8

First Aid
for Builders of
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Ancient and Modern

Plans—Scale Blueprints of historic and modern vessels, racing sail yachts and power boats

Lumber—Selected white pine for hulls, straight grained spruce for spars, three ply veneers for decks, mahogany, etc.

Tools—Specially designed—Chisel—Gouges and Planes to fit exactly modelmakers' needs

Hulls—Made to Scale of selected white pine in the rough partly finished or completely finished

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Model Sailing Boats—Complete ready to sail or construction sets

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Marine Engines—Complete Steam Engines, Construction Sets in different stages of completion, spring motors

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Brief history of Steam Engines

Illustration of famous models made by the House of BOUCHER

Nautical terms in common use

Parts of a sailing vessel—spars, rigging, knots, hitches and splices commonly used on boats

Hints for painting and finishing Model Boats

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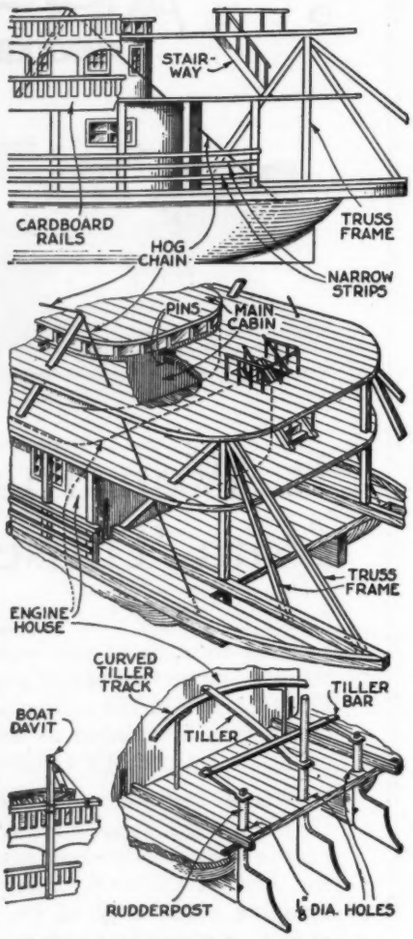
Building the *Buckeye State*

(*Continued from page 92*)



Fittings at the stern of the model, including trusses, hog chains, ladders, rails, and rudders.

lower and upper handrails and where the edge of the upper deck comes. Apply a similar piece inside along the top edge.

Unless the weather is very humid, these pieces will have to be dampened by dabbing them with a moist cloth before they are applied; otherwise, however well glued on, they will buckle in damp weather.

Glue them on and hold them in position until dry with glass-headed pins (these are sharp and easy to handle). Along the inside of the upper part—and the lower, too, if you wish—some thin strips of wood from the rail to the deck will look well and stiffen the whole. Give the whole one or two coats of flat white paint and a coat of white enamel.

NEXT should come the deck on the cabin, which is similar to the other decks and projects a full ⅛ in. all around. Also put on the texas because its bulk can be easily grasped and will save the handrails and other delicate parts from damage in handling the model.

The texas of my model, as shown in the upper photograph on page 92, has not as many windows as it might have because I had doors between and then found when all was finished that there would have been no way in which anyone on board could reach them, so had to cover them up.

The texas can be made by either of the methods described last month, but preferably by the built-up method, which leaves it hollow. The lines of its sides will coincide with the side lines of the cabin. It is round in front and square abaft. There should be two doors abaft for entry. It will have a deck similar to those below.

The hog chains (Main Chains No. 2) should now be fitted. For the after strut bore through both decks into the top of the engine room, paint the strut black, and glue it in position extending above the upper deck 5/8 in. For the forward one we already have holes in the lower decks; make another in the upper in line with them and put it in position to extend only 3/16 in. Bore holes for the wires, then reeve the ends down through. Turn up the forward end of each and drive it into the hull, stretch it over the struts, draw it down tight aft, and turn the end up. Do this on both sides, of course.

PLACE the forward and after ladders in position. The forward ones need handrails on the outside only. The after hole needs a guardrail on three sides, but the forward ones, where the deck is so narrow, need be guarded on only two sides. Note that the side supports of the forward guardrails are on the top of the cabin and are shorter than the posts which extend from the upper deck.

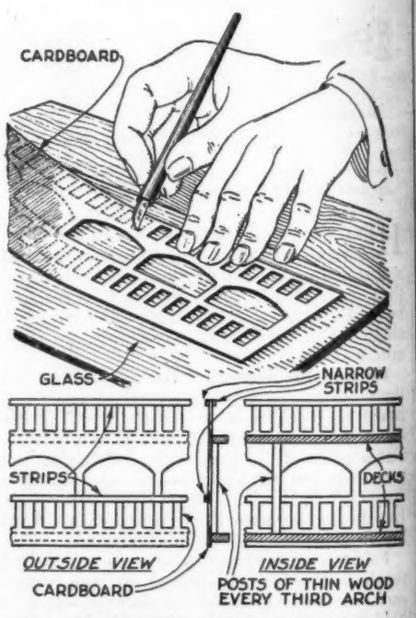
On the original model the upper ladder handrails are of brass wire and the lower of wood.

We have yet to put the four slanting cross timbers on either side between the lower decks. They extend from main to boiler deck and are similar to the lower stanchions; they are nailed outside all. Their positions are shown clearly on Blueprint No. 96 and in the upper photograph on page 92.

The boat davits, which also are shown on Blueprint No. 96, may now be put in position. They are merely square posts, glued to the deck edges outside everything else and perhaps lashed with thin thread to the upper handrail. They have the smallest possible double blocks lashed to their upper ends on the outside. These and the lower stanchions should be painted white. The lowest handrail may be white or mahogany color.

Before we build any higher we had better make and fix the rudders and stern wheel.

There are three rudders moving in unison, as shown in the drawing (*Continued on page 124*)



The Bristol board rails are prepared in two long pieces, one for each side of the model.

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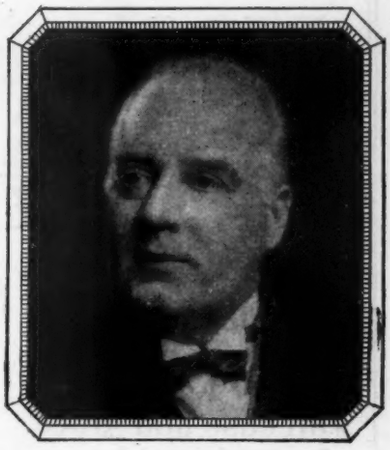

NO matter how lacking you are in qualities of leadership, no matter how colorless, timid, unsuccessful and discouraged you may be, I GUARANTEE to so magnetize your personality that your whole life will be completely transformed!

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You have it—everyone has it—*but not one person in a thousand knows how to use it!* It is not a fad nor a theory. It is simply you, yourself—your manner—your own marvelous personal force, released and magnified a hundredfold in an amazingly clear-as-crystal, scientific way! More necessary than good looks. More valuable than money. For without it a salesman is handcuffed! Without it a business man is powerless to command! No actor, no teacher, no orator, no statesman can long hold his audience spellbound without this supremely influential magnetic force!

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Personal Magnetism is not hypnotism. Hypnotism deadens. Magnetism awakens, inspires, uplifts. Personal Magnetism is not electricity. It is like electricity in one way—while you cannot see it, you can observe its startling effects. For the moment you release your Personal Magnetism you feel a new surge of power within you. You lose all fear. You gain complete self-confidence. You become almost overnight the confident, dominant, successful personality you were intended to be—so fascinating that people are drawn to you as irresistibly as steel is drawn to a magnet!

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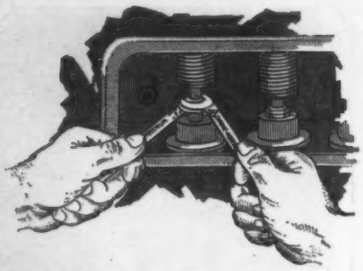

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The *Buckeye State*

(*Continued from page 122*)

on page 122. They must be accurately fixed so that they will be almost in line with the boat's bottom and allow the wheel to turn in their curve. They can be of wood or metal, the former being the easier to use. They had better be in one piece with their posts. Note that the outside posts are short, but the center one extends just through the boiler deck, because that rudder has no support under the main deck.

Into each sternpost drive eyes made of pins, and into the outside rudders drive and bend over pins to fit in the eyes. For the unison gear make three tillers: one long with two holes, and two short with one hole in addition to the necessary square holes which fit tightly on the rudderposts. The tillers can be made of sheet tin or copper. Join the three with a bar having holes which correspond with the distances between the holes for the rudderposts. Rivet the bar to the tillers with escutcheon or large pins.

Pass the rudderposts through their holes and set the tillers on them at an upward slant so that the center tiller rests on the railway previously installed.

Set the pintles in the rudders into their gudgeons in the sternposts and drive a pin through the center rudderpost above the deck to prevent it from dropping lower than the others.

The wheel and remainder of the fixtures will be described next month.

Mississippi Books

ADDITIONAL information about Mississippi steamboats and many facts about the dramatic history of the Valley can be gained from the books listed below. The list was prepared by Captain McCann during the careful study he made of the literature relating to river steamships. He found particularly interesting and valuable the books that are starred. Those volumes which have the price indicated can be obtained through the Book Department of POPULAR SCIENCE MONTHLY; the others, the majority of which are out of print, are available in many public libraries.

American Steam Vessels, Samuel Ward Stanton.

Chronological History of Steam Navigation, A. G. H. Preble.

Down the Great River, Willard Glazier.

Early Western Travels, Ruben G. Thwaites.

Early Steamboat Travel on the Ohio River, Leslie S. Henshaw.

Fifty Years on the Mississippi River, Emerson W. Gould.

**Genesis of Steamboating on Western Rivers*, Geo. Byron Merrick.

History of American Steam Navigation, John H. Morrison.

**Life on the Mississippi*, Mark Twain ($2.50).

Life on the Western Rivers, John Habermehl.

**Mississippi River, The*, Julius Chambers ($5.00).

***Mississippi Steamboatin'*, H. and E. Quick ($3.00).

Old Times on the Upper Mississippi River, Geo. Byron Merrick.

Progress of Navigation and Commerce on the Mississippi and Great Lakes, John W. Mormetts.

Steamboat Days, Fred Irving Dayton ($5.00).

Father Mississippi, Lyle Saxon ($5.00).

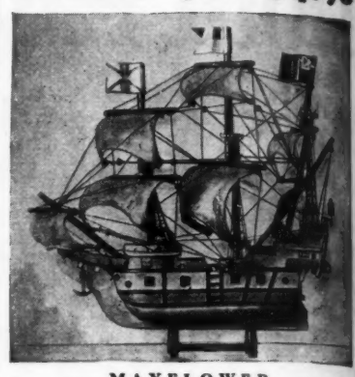
A-Rafting on the Mississip', Charles Edward Russell ($2.50).

The Romance of the Rivers, John T. Faris ($6.00).

Show Boat, Edna Ferber ($2.00).

The last four books are comparatively recent, and so great is the present interest in Mississippi steamboating that other books are certain to appear. The above bibliography does not pretend to completeness, but offers a fairly wide field for further study.

A $100.00 SHIP MODEL for $4.98



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SIZE 25" High; 10" Wide; 26" Long

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Please send me the complete parts cut to fit and ready to put together for the MODEL . . . . . [I will pay Postman $ _____ plus a few cents for postage.
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Gift box with every ring

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"Don't make a monkey of yourself"

cried Bob as I sat down at the piano

BOB was always putting his foot into things.

I was spending my vacation with him when I met his cousin, Helen. Instantly all other girls faded out of my life. It was love at first sight. But unfortunately she didn't seem to feel the same way about me.

Like all young lovers, I confided my troubles to the nearest willing ear. It happened to be Bob's.

"You've got nothing to worry about," he insisted when I finished my tale of woe. "Just leave it to me. All you need is a little publicity. . . ."

Right then and there I knew I should have kept my mouth shut.

The very next day he announced that he'd just had a long talk with Helen and according to him, "put me over big."

"Boy! What I didn't tell her about you is nobody's business!" he exulted. "When I got through with my little song and dance about what a whiz you are at the office, I pulled my trump card . . . and believe me, it boosted your stock sky high!"

"What was it?"

"Well, you see, she's crazy about music. So I conveniently forgot that you can't play a note, and told her you are *an accomplished pianist!*"

"But Bob . . ."

"Not another word! I've got you sitting pretty, now. If by any chance you're asked to play—just say that you've sprained your wrist playing tennis. I'm some little fixer, eh, what?"

That very night we were all invited to the Carews' party. On the way over, I sensed a big difference in Helen—a difference that made my heart beat fast with a new hope. Perhaps, after all, Bob was a good fixer.

A little later in the evening we were all gathered around the piano, listening to the rather indifferent performance of one of the guests.

I Am Asked to Play the Piano

"I'm just dying to hear *you* play!" cried Helen. "I've heard so much about your talent! Won't you play something for us?"

"Yes!" "Yes!" "Please!" came from all sides.

With a smile I bowed low . . . and replied that *it would be a pleasure.*

Glancing up I saw Bob's grin change to amazement. This was not part of the plan! Calmly ignoring his frantic signals I walked over to the piano.

Quick as a flash Bob followed me. "For the love of Pete get away from that piano," he whispered excitedly. "Don't make a monkey of yourself. If Helen ever hears you play she'll think everything else I told her is bunk, too!"

Turning to the guests in an effort to save his own skin, Bob announced, "Perhaps we should wait until some other time. You see, his wrist was slightly sprained in tennis this afternoon, and . . ."

"Oh, that's nothing!" I broke in, and as he looked at me dumfounded, I sat down at the piano.

* * * * *

Without any further hesitation, and with a secret smile at the surprise I had up my sleeve, I began the first notes of Irving Berlin's famous "Russian Lullaby!" The tantalizing, irresistible strains seemed to throw a spell over the guests. One by one they quietly moved nearer the piano until soon I was completely surrounded by rapt listeners.

Bob was so stupefied that all he could do was to stand there in open-mouthed amazement.

On and on I played—losing myself in my music. I forgot Bob's astonishment—forgot the glow of admiration in Helen's eyes—forgot everything but the beautiful melodies that always opened a new world for my enchantment. Swept away by the sheer magic of Berlin's genius, I was unaware of the silent tribute that followed my playing until thunderous applause shook the room.

That brought me to myself with a start. For the rest of the evening I was the lion of the party.

Bob could hardly restrain his curiosity until we were safely home.

"Boy! You sure stopped that party dead!" he exclaimed. "You could have knocked me over with a feather when I heard you actually *playing!* Why didn't you tell me you knew how?"

"You never asked whether I knew how to play," I countered.

"Of course not! Last summer you didn't know one note from another—how was I to guess you'd blossomed into an accomplished pianist overnight?"

"Not overnight, exactly!" I smiled. "Although it almost seemed that way! Remember that Free Demonstration Lesson in music I sent for?"

"You don't mean the one that was supposed to show you how to play without a teacher, do you?"

"The same! All the fellows said it was a fool stunt and that I was crazy to send for it. Well, it happened to be the best bit of luck that ever came my way! I didn't say anything about it because I didn't want every one laughing at me when I sent for the course. That course certainly is wonderful!"

"So you really *are* an 'accomplished' pianist! The joke's on me, all right!"

"Oh, I wouldn't say 'accomplished,'" I laughed. "But enough of a pianist to get a lot more fun out of life than I used to!"

You, Too, Can Learn to Play *Without a Teacher*

The above story is typical. You, too, can learn to play your favorite instrument by this remarkable "at home" method that has helped almost half a million people all over the world to increased pleasure and financial gain. You don't have to know the slightest thing about music. First you are *told* what to do—then a picture *shows* you how to do it—then you do it yourself and *hear* it. No private teacher could make it any clearer.

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Please send me your free book, "Music Lessons in Your Own Home," with introduction by Dr. Frank Crane, Free Demonstration Lesson and particulars of your easy payment plan. I am interested in the following course:

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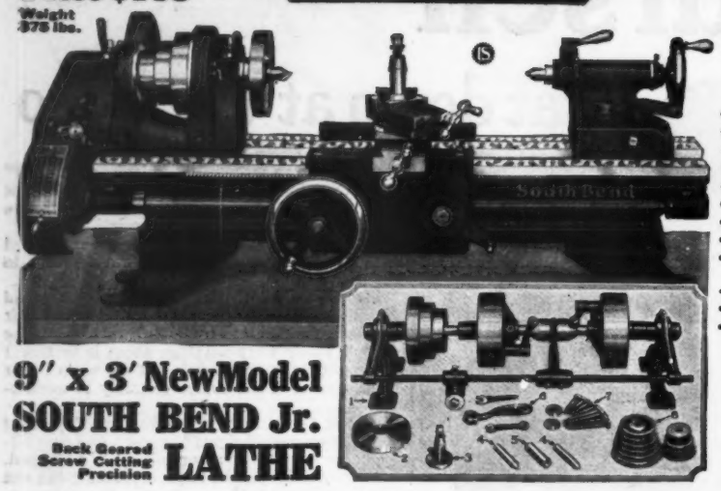

This Lathe Will

—Do Turning
—Boring
—Chucking
—Grinding
—Cut Screw Threads
—Make Bushings
—Reface Valves
—Finish Pistons
—Bore Connecting Rods
—Undercut Mica
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—and do hundreds of other jobs in the Machine Shop
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9" x 3' New Model SOUTH BEND Jr. LATHE

Back Geared Screw Cutting Precision

We ship Lathe immediately upon receipt of small down payment, and give you 10 months to pay balance in equal installments. With each Lathe we send Free Complete Instruction Book, "How to Run a Lathe."

Features and Specifications

Power Feed to Carriage
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Width of Belt—1 in.

Also furnished with floor legs and in three types of Motor Drive, one of which is shown below

Prices and Terms of 9-inch Junior Lathes

Bise Lathe	Between Centers	Weight	Down Payment	Monthly Payment	Price Lathe
9"x2½'	11 in.	350 lbs.	$30.00	$12.00	$150.00
9"x3'	18 in.	375 lbs.	31.00	12.40	155.00
9"x3½'	23 in.	400 lbs.	32.00	12.80	160.00
9"x4'	29 in.	425 lbs.	33.00	13.20	165.00
9"x4½'	36 in.	450 lbs.	34.00	13.60	170.00

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You can install any South Bend Lathe by making a small payment with your order and take care of the balance in small monthly payments over a period of ten months. We ship as soon as the down payment is received.

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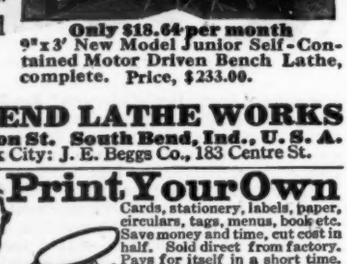

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Protect Your Tools From Theft. Write with electricity any name or design on the hardest and finest tools and instruments, or any metal, like writing on paper with pen or pencil. Complete Outfit $1.50 Prepaid Anywhere. Interesting illustrated circular free. Write today. Agents wanted.
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Own This Better H & A Saw Table

A sturdy, powerful, large capacity machine that will handle wide material. Accurate, speedy, reasonably priced. Use it for ripping, cross-cutting, mitering, grooving, rabbeting or dadoing. Equipped with tilting fence for bevel sawing; ½ or ¾ H.P. motor; ball bearing spindle. Write for catalog of woodworking tools.

HESTON & ANDERSON
802 Market Street, Fairfield, Iowa

Decorative Metal Sawing

(*Continued from page 76*)

blade should be straight up and down. When you come to a corner or sharp angle, do not push the saw forward at all, but turn the saw frame slowly as you move it up and down. The saw will cut a hole for itself to turn in; then you may resume sawing in the usual way.

On some types of work much time can be saved by drilling holes for the saw to turn in at all sharp angles. It is always necessary, of course, to drill at least one hole in each interior part which is to be cut out. The blade is inserted through the hole after being loosened at one end from the frame.

If you rub a lump of beeswax or a candle on the blade at intervals, it will help the sawing. Brass is probably the metal easiest to saw, but silver and gold are both excellent. Copper tends to cling to the blade.

Very thin metal such as No. 28 or 30 gage is best fastened with shellac to a piece of

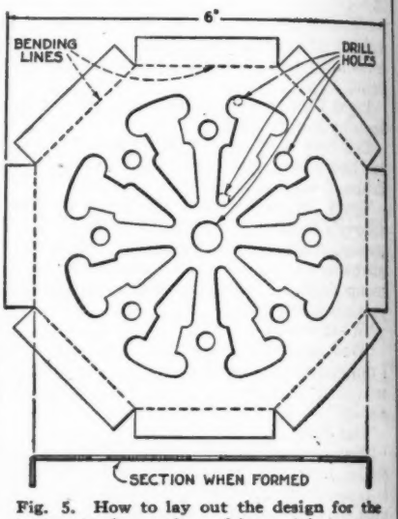


Fig. 5. How to lay out the design for the teapot stand on a piece of brass .6 in. square.

cigar-box wood or even thick pasteboard. Later the metal is removed from its backing by heating it. Very thin, fine-toothed saws must be used for such delicate work.

After practicing on scrap metal, the beginner can make the teapot "tile" or stand illustrated in Fig. 4. Brass is the best metal to use.

First draw the design as in Fig. 5, or, better still, make up a simple design of your own of the same type and then transfer it to a piece of No. 18 gage clean flat brass. Scribe in the lines.

The eight-sided shape may be cut out with a pair of stout metal shears, but it is excellent practice to saw to the outline. Drill a hole in each interior part and remove any roughness left by the drill on the underside of the metal. Next saw out the design; then file the cut edges on the bench pin as shown in Fig. 2 using small needle files and larger half-round or crossing files, which have very fine teeth.

Leave no raw edges; all must be well rounded or chamfered. Fairly coarse, followed by fine, emery cloth, if torn into narrow strips, may be used to smooth down the edges after they have been filed. For this work hold the tea stand between the vise jaws, but place paper to protect the metal from the jaws.

The edges may be turned down over a clean-cut block of wood held in the vise as in Fig. 3. Do the hammering with a wooden mallet. The corners of the bent-over parts do not need to be soldered. Polish or finish the piece in any way you wish.

Many similar projects, such as blotter corners, paper knives, and watch fobs, may be made in the same way as the tea tile.

This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

Fastening Objects to Plaster Walls

Paste this Home Workshop Reference Sheet, including the head above, in your scrapbook in the section marked *walls*. (Feb., 1929, POPULAR SCIENCE MONTHLY.)

How do you drive nails in plaster walls?

NAILS will hold in plaster walls only when driven right through the plaster into one of the wall studs, or uprights, to which the lath is fastened. To find one of these uprights, tap the wall very gently with a hammer and listen to the sound. The sound is hollow in tone except where the studs are located, and there is a perceptible difference in the rebound of the hammer.

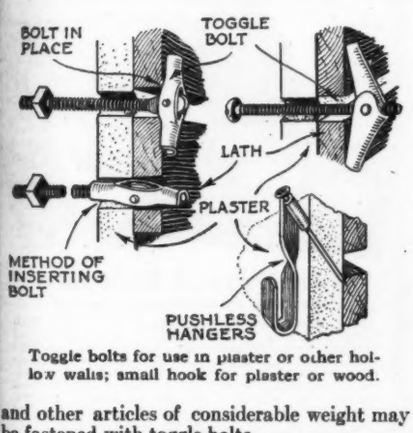
If you find it to be difficult or impossible for you to detect these differences, look at the baseboard and note where it has been nailed. The nails are driven into the studs, and there is usually good nailing at any point in a vertical line directly above them. Drive a thin finishing nail carefully through the plaster to make sure that the stud has been located.

Studs ordinarily are placed 16 in. from center to center; you can, therefore, locate other studs by measurement after the first is found.

If large nails are to be used, drill holes through the plaster so that it will not be chipped. Use an ordinary twist drill, fluted drill, or gimlet bit.

How can something be fastened to a plaster wall at a place where there is no stud to give good nailing?

1. Obtain a toggle bolt (see the illustration below) of suitable size and drill a hole to receive it. Plumbing fixtures, clocks, shelf brackets,



Toggle bolts for use in plaster or other hollow walls; small hook for plaster or wood.

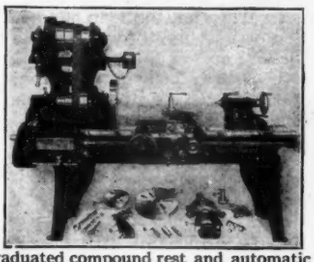
and other articles of considerable weight may be fastened with toggle bolts.

2. Light objects, such as pictures or mirrors, can be hung by means of the hooks or "pushless" hangers shown, which are sold in various sizes according to the weights they are intended to support. These may be used anywhere, without reference to the studs behind the plaster. Drive the pins carefully, especially the larger sizes, *(Continued on page 128)*

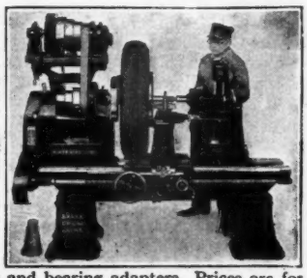
Big Savings on LATHES for the Tool Room-Manufacturing Machine Shop-Repair Shop-Service Station

New Model South Bend Back Geared Screw Cutting Precision Lathe
More than 42,000 in Use in U. S. and 78 Foreign Countries

9"x2½' Junior Back Geared Screw Cutting Bench Lathe. Has power feed to carriage, compound rest, ¾" hole through spindle and phosphor bronze spindle bearings. Also made with 3, 3½, 4, and 4½ foot beds. Weight 350 lbs. Complete with Countershaft and Equipment.....Price **$150**



18"x8' Quick Change Gear Silent Chain Motor-Driven Lathe with reversing motor and reversing switch. Lathe is Back Geared, Screw Cutting. Has graduated compound rest and automatic feeds. 1 7-16" hole through spindle. Weight, 3240 lbs. Complete with Motor and Equipment. Price..... **$908**



Motor Driven Brake Drum Lathe—handles all brake drum work without removing tires. Services all types of brakes on all motor cars, buses and trucks. Also handles ring gear work. Self-centering mandrels and bearing adapters. Prices are for Lathes complete with Motor.

No. 1 Lathe for wheels to 32" diameter **$610**
No. 2 Lathe for wheels to 36" diameter **$805**
No. 3 Lathe for wheels to 42" diameter **$1754**

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South Bend Lathe Works
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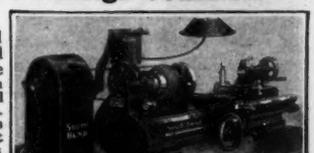
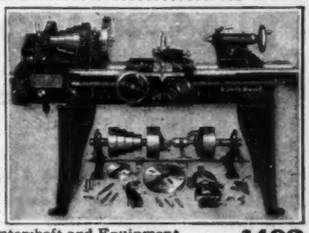
South Bend, Indiana, U.S.A.

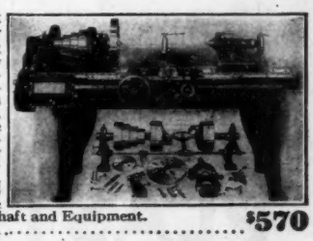
New York City: J. E. Beggs Co., 183 Centre Street
Carried in stock by Machinery Supply Dealers in Principal Cities throughout the World.



New Model South Bend Junior Lathe equipped with Horizontal Motor Drive. Same lathe as illustrated at **right** except with motor drive added. Connects to any ordinary light socket for power. Price with Motor..... **$226**



13"x5' Quick Change Gear Lathe. Back Geared, Screw Cutting. Compound rest, automatic feeds to carriage. 1" hole through spindle. Phosphor bronze spindle bearings. Weight, 1110 lbs. Complete with Countershaft and Equipment. Price..... **$402**



16"x8' Quick Change Gear Lathe. Back Geared Screw Cutting. Compound rest, automatic feeds to carriage, 1⅜" hole through spindle. Phosphor Bronze Spindle Bearings. Weight 2035 lbs. Complete with Countershaft and Equipment. Price..... **$570**

Easy Payments if Desired

You can secure any South Bend lathe by making a small payment with your order, and take care of the balance in small monthly payments over a period of 10 months. We ship Lathe as soon as down payment is received.

SOUTH BEND LATHE WORKS
819 E. Madison Street, South Bend, Ind., U. S. A.
Gentlemen: I would like your net factory price on a Screw Cutting Lathe. Size..... for (check kind of work)
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Please send free Catalog No. 89-A.
Name .....
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12-inch scale model of Lindbergh's Spirit of St. Louis. Scientifically designed and very realistic. Rises from ground by own power and flies 30 ft. or more. Stays in air 8 to 10 seconds. Easily built in 3 hours. No tools needed. Construction set, with all parts and full directions, postpaid in U. S., only 50c. (No stamps.) Satisfaction or money back. Send today.
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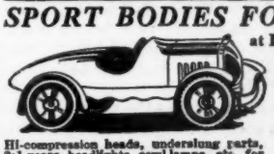
at FACTORY PRICES



This Model in Grey Prime **$38.50**

Hi-compression heads, underslung parts, 3:1 gears, headlights, cowl lamps, etc. for Fords. Seat Covers for all cars.

Send 10c for catalog showing all models of bodies for Fords and other equipment. Also boats, tents and camping outfits.

SPORT FACTORIES Dept. D-3 **AURORA, ILL.**

Build a CLOCK *for Pleasure or PROFIT*

FREE BOOK
Chock full of Clock-Making and *Money-Making* ideas. Gives full details, descriptions, prices of movements and parts. Write NOW for your copy

Shows how YOU Can Make Fine Clocks Right at Home

THOUSANDS of men have built our Clocks. For their own use—or to sell at *money-making* prices. It's easy, fascinating. Only ordinary tools needed. We furnish plans, instructions, parts. Works all assembled, ready to install, as low as $1.65; others with chimes at all prices. You make the case, or simply assemble knock-down parts. Cash in on the demand for craftsman-built Mantel Clocks, Banjo Clocks, Grandfather's Clocks. Here's a hobby that PAYS—in pleasure, in ownership and in spare-time or full-time PROFITS!

Write for FREE Catalog and Special Blue Print Offer
AMERICAN CHIME CLOCK COMPANY
1691-B Ruffner St. Philadelphia, Pa.

Where's the can of

PLASTIC WOOD?

Reg. U. S. Pat. Off.

What if a fixture has pulled out—and towel racks, glass holders, and other fixtures set in tile do come loose?—it is easy enough to fix them permanently with Plastic Wood. Just clean the hole to remove loose plaster, wood, or dirt and fill it up with Plastic Wood—the amazing household product that handles like putty and hardens into solid wood. Then, when hard, screw the fixture back in place—or, if it has no screws, "set" it while the Plastic Wood is still soft.

PLASTIC WOOD

[Reg. U. S. Pat. Off.]

It comes in two forms—Plastic Wood, of natural wood color, and Plastic Wood White Waterproof Tile Cement, which dries to a hard flat white, and is particularly useful around loose tiles and other places in a tiled bathroom where a white finish is desired.

Plastic Wood is waterproof, greaseproof and weatherproof. It has a thousand uses indoors or outdoors, and for the handy man it helps in almost any wood-working job for sealing joints, filling cracks, moulding, or repairs.

Plastic Wood Solvent

When working with Plastic Wood, keep a can of Plastic Wood Solvent on hand to soften it if it hardens too rapidly, to thin it if necessary, and to clean the hands and tools after using. At dealers, in 25 and 50 cent cans.

Handles like Putty

Hardens into Wood

1 lb. $1.00 ¼ lb. 35 cts.

At Hardware and Paint Stores

ADDISON-LESLIE COMPANY
312 Bolivar Street Canton, Mass.

Plaster Wall Fastenings

(*Continued from page 127*)

to avoid chipping the plaster. Indeed, it is better when the larger sizes are used to take the pains to drill holes at the correct angle for them.

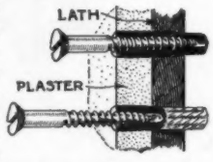
To drive one of the pins, first withdraw the pin until the hook can be held firmly against the wall; then drive the steel point home.

How do you drive screws in plaster walls?

1. Locate the stud behind the plaster as previously described and drive a 1½ in. long screw through the lath and plaster into the wood. It will penetrate the stud about ¾ in., which is usually far enough to hold any ordinary picture or other object. Before driving the screw, drill a hole through the plaster of a diameter equal to the unthreaded part of the screw, and a hole in the stud a trifle less in size than the root diameter of the threaded portion of the screw.

2. When no stud is to be found in the position desired, use a toggle bolt as described in the first answer to the previous question.

3. Drill a hole in the plaster just large enough to receive a prepared commercial fiber plug of the kind illustrated. This has a small hole through the center into which the screw is driven. The fiber wedges and binds the screw tightly in plaster, tile, cement, stucco, and similar materials.



Special plug for use in plaster, tile, cement, and stucco.

4. Between studs it is often possible to drive a 1¼-in. screw so as to take good hold in a wooden lath. Such a screw will usually hold surprisingly well, but sometimes it will fail. A toggle bolt, mentioned in paragraph No. 2, is far stronger.

5. For very light work, a hole can be drilled in the plaster a little larger than the screw and filled with patching plaster or plaster of Paris and water. Turn the screw gently into the soft filling and with a knife smooth down the plaster around the screw. If it is desired to have the screw removable, the threads should be wrapped with copper wire and both screw and wire pressed, not turned, into the plaster filling. The wire is held firmly when the plaster hardens, but the screw can be turned out. This expedient is more useful in connection with cement walls and floors, in which case Portland cement is used instead of plaster for embedding the screw. Iron cements and plastic wood preparations are often used in the same general way. In no case should any weight or strain be put on the screws until the cement has become thoroughly hard.

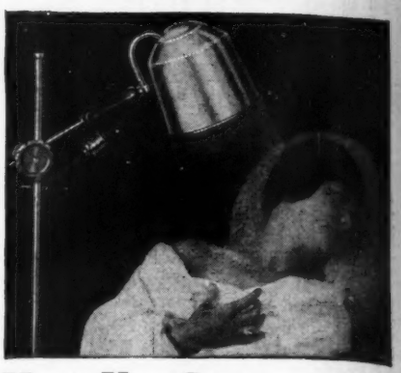
How to Waterproof Shoes

SHOES can be made waterproof or at least highly resistant to moisture by the use of one of the following formulas recommended by chemists of the U. S. Department of Agriculture:

Formula 1: Neutral wool grease, 8 oz.; dark petrolatum, 4 oz.; paraffin wax, 2 oz. Formula 2: Petrolatum, 16 oz.; beeswax, 2 oz. Formula 3: Petrolatum, 8 oz.; paraffin wax, 4 oz.; wool grease, 4 oz.; crude turpentine gum (gum thus), 2 oz. Formula 4: Tallow, 12 oz.; cod oil, 4 oz.

Which formula to use depends upon the ease with which the materials can be obtained. These ingredients must be melted before being mixed and applied warm, but not hot, to all outside parts of the shoes or boots. The soles are then saturated by setting the shoes or boots in a shallow pan with sufficient melted grease to cover the soles. Rubber heels, however, must be kept out of the mixture.

CAMPBELL'S INFRA-RED RAY LAMP



Have You Some Troublesome Ailment?

You will be greatly surprised when you learn how Infra-Red Rays relieve congestion or troubles causing aches and pains in the body. The Campbell Infra-Red Ray Lamp concentrates a mild beam of Infra-Red Rays upon any part of the body.

These rays penetrate deeply into the tissues. As they penetrate they create an active circulation of the blood. Most ailments are due to congestion—relieve the congestion and you relieve the ailment. Nature herself does the healing by active, normal blood circulation.

Why Suffer Needless Pain?

If you or some one in your home have a troublesome ailment, a lamp like this is a blessing. May be used safely by anyone. Entirely unlike ultra-violet or X-Ray. Positively cannot sunburn or blister.

Relieve bronchial trouble, Neuralgia, Neuritis, Sinus trouble, Catarrh, head noises, Asthma, Ear trouble, Rheumatism, Hemorrhoids, Prostatitis, Gall-Bladder, Tonsilitis, Lumbago and many other ailments with soothing Infra-Red Rays.

Let Us Send You Our Book on Infra-Red Rays

We have an interesting book on the use of Infra-Red Rays which we shall be glad to send free to any reader upon request. Our book quotes leading authorities as well as users of our lamp. Full directions for use, how to order, our home trial offer, etc., are also explained.

Infra-Red Rays have brought such wonderful results for others you are sure to be interested. Write today for our book telling more about it.

THE WILLIAM CAMPBELL COMPANY
1041 Union Avenue · Alliance, Ohio

REGISTERED TRADE MARK
CHEMCRAFT
THE OUTFIT

Have Days of Real Fun

Learn the Wonders of Chemistry

Anybody can master the science of chemistry with CHEMCRAFT. Work hundreds of amazing and useful chemical experiments; make soap, ink and dyes; test foods, water and soil; produce startling changes and perform wonderful tricks of chemical magic. CHEMCRAFT is the original and best chemical set; has more chemicals and experiments. Get CHEMCRAFT—then your fun begins!

Seven Dandy Outfits to Choose From:

No. 1—$1.00 No. 3—$3.50 No. 9—$ 8.00
No. 2—$2.25 No. 5—$5.00 No. 12—$12.00
Laboratory Work Bench $35.00

Sold Wherever Good Toys Are Found

Try Chemistry for 25c
Get CHEMCRAFT Junior, the set for boys who want to see if chemistry interests them. Sent postpaid for only 25 cents. Order it today!

Free Magazine for Boys
CHEMCRAFT Chemist Club Magazine, full of fine ideas, stories, chemical stunts and information. Write for your Free Copy at once.

THE PORTER CHEMICAL COMPANY
115 Summit Ave., Hagerstown, Md.

From soft pine blocks, a boy can easily cut picturesque buildings.

"What Can I Make from a Block?"

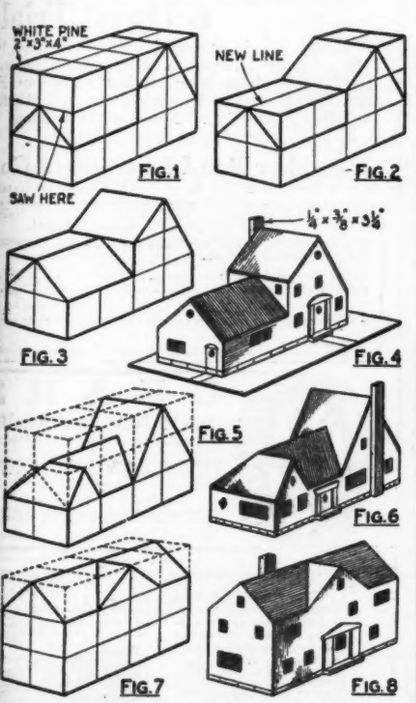
By DONALD W. CLARK

EVERY boy at some time or other has held a block of wood in his hand and asked himself: "Now what can I make out of this old chunk of wood?"

Why, hundreds of things!

For example, a whole miniature village can be cut easily from blocks of white pine. Small auxiliary parts can be made of bits of wood or heavy cardboard and glued on. The completed buildings can be painted in various colors and given red or green roofs. Then they can be placed in a suitable setting with streets, trees, shrubbery, and accessories.

Line off each block in 1-in. squares. Mark with heavier pencil lines just where you intend to begin cutting, and then use a fine saw and a knife to work out the finished forms. In the absence of a fine-tooth wood saw, a hack saw blade can be used, and a keen pocketknife will reach the places where the saw cannot reach.



Steps in blocking out and shaping the houses. Much depends upon painting them neatly.

PUT THIS WORK SHOP IN YOUR HOME FREE For 10 Days-No Deposit!

A New and Improved Workshop

Here is a workshop built to a standard of perfection—accurate in operation—most durable in construction—easy to operate. It is absolutely dependable and will withstand severe constant service. Try it for ten days at our expense and you will be convinced of its superiority.

Suitable for Carpenters, Home Workers, Pattern Makers, etc.

Furniture manufacturers use MAC, THE POPULAR MECHANIC Workshop, for making furniture models. Manual Art Schools use it for instruction. Home workers use it for pleasure and profit. Carpenters use it for making repair parts, spindles, chair legs, cabinets. It is ideal for making all kinds of furniture.

MAC THE POPULAR MECHANIC TURNS, RIPS, CROSSCUTS, DRILLS, SURFACES, POLISHES, GRINDS, CUTS SCROLLS. A PERFECT WORK SHOP

The Lowest Price For Such a Sturdy, Complete Workshop

MAC, THE POPULAR MECHANIC, represents the utmost in value and dependability. Now you can have an accurate, practical workshop at a big saving. Once you use MAC you will be convinced of its superior qualities. That's why we want you to *try it for ten days* at our expense.

NO DEPOSIT | A YEAR TO PAY | GET DETAILS QUICK

MIDLAND APPLIANCE CORPORATION
Dept. 220—219 N. Michigan Ave.
CHICAGO, ILL.

ZIP-ZIP SHOOTER

Boys: join a Zip-Zip Shooters' club everywhere boys are forming these clubs, fine sport using this shooter which is scientifically and practically made, Zip-Zip Shooter is the best buy we know of for 35c or 3 for $1.00. We will ship to you if your dealer can't supply you.

AUTOMATIC RUBBER CO., Columbia, S. C.

SPEEDO-[illegible]-PLANE FLYER

Rises from the ground, soars to great heights; comes down in a graceful glide to a perfect landing. Wing spread 16 in. Motor stick 14 in. 7-in. carved wood propeller. Match its performance against your $5 plane. Fully assembled; Only 60 cents postpaid in U. S.

SPEEDSTER AIRPLANE

Fast flyer. Rises from ground under its own power. Speeds beautifully through the air. 11-in. wing spread. 9 1-2 long. 4 1-2 in. carved wood propeller. Only 25 cents postpaid in U. S.

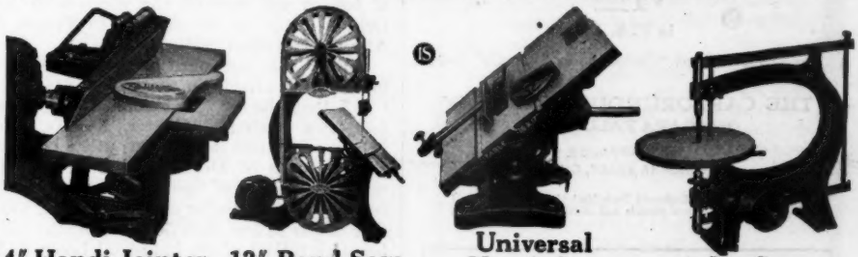
Both Models Guaranteed to Fly or Money Refunded

Special for this month.—Snappy, live rubber, 1-8 in. flat, 1-2 cent per foot; 3-16 in., 1 cent per foot. Postage 5c extra.

SPEEDO MFG. CO., Dept. S. 253 Albany Ave., Brooklyn, N. Y.

Still Greater Bargains in Boice Machines

Boice-Crane, the world's largest builders of small bench machines, now offer you the very greatest bargains in their 14 years' experience. Fifteen different Boice-Crane Machines. Unsurpassed quality and capacity Seven choices of 2, 3, 4, or 5 machine workshops completely motorized and with individual machines. Pra tical, fully capable, no attachments to change. Astonishingly low priced at $48, $70 and up.



4" Handi Jointer — Tables 20-inch ground and polished. Planes ¼x4-inch. Fence tilts 45 deg. both ways. Improved rabbet arm. Bronze bearings. Safety guard $3..... **$25**

12" Band Saw — Table 10x12 inches tilts 45 deg. Cuts 4½-inch deep. Bronze bearings. Copied after our famous 14-inch band saw. Guards, $8. Sturdy construction. *Without motor or guards...* **$35**

Universal Handi Saw — Table 15x17 inches tilts 45 deg. 8-inch saw cuts 2-inch. Elevates for dadoing. Always accurate. Pulley between bronze bearings. Attachments for dadoing, jointing, disc & drum sanding, boring, thickness planing, grinding. Wgt. 60 lbs. Big value **$30**

Jig Saw — Table 8-inch dia. tilts 45 degrees. Ground smooth. Vertical stroke 1½-inch. Capacity 10-inch to frame. 6 sizes of blades, ½" to ¾". Speed 600 RPM..... **$12**

5 Models of Lathes for turning wood and metals **$13.50 and up**

W. B. & J. E. Boice, Dept. P.S.2-E Toledo, Ohio

Send 10c for Boice-Crane's new 1929 catalog of 80 pages. Describes books of designs and instructions containing 450 designs of furniture, toys and puzzles. Investigate Boice-Crane bargains in machines and workshops before you buy.

This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

NOW! ADJUSTABLE

The CARBORUNDUM
REG. U. S. PAT. OFF.
DETECTOR

A TURN of the pressure screw gives you perfect tone balance. Then the position is fixed by adjusting lock nut, so that the pressure remains permanently sensitive.

¶Just another improvement to further assure the perfect tone quality you always get with the Carborundum Detector—and tone quality is everything.

¶Recommended by noted radio-circuit designers.

DEALER OR DIRECT

$1.50

in U. S. A.

Send for Free Book "Carborundum in Radio" D-6

THE CARBORUNDUM COMPANY
NIAGARA FALLS, N. Y.
CANADIAN CARBORUNDUM CO., LTD.
NIAGARA FALLS, ONT.

{Carborundum is the Registered Trade Mark of The Carborundum Company for its Silicon Carbide and is its exclusive property}

THE CARBORUNDUM COMPANY
NIAGARA FALLS, N. Y.

Please send me your free Hookup Book entitled "Carborundum in Radio"—D-6.

Name_____

Address_____

Liquefied Helium Boils on Ice and "Freezes" Tin

(*Continued from page 28*)

shaft in the air and take the weight off the bearings?

Ross V. Gardner, in charge of trade research work, has a bushel basket full of such inquiries. For the advertising man he patiently figured out that a silk and rubber balloon ten feet long and as wide and high would be needed for his windmill. He disposed, too of the inventor who would put a buoyant helium tank at the front of his speedboat to lift it out of the water—and another who proposed to inflate an automobile inner tube with helium and also to use it as a life-preserver to jump from the top of a burning building. The latter had so much confidence in his invention that he proposed to test it himself. Luckily that calamity was averted.

SERIOUSLY, one commercially important use for helium has been found in the filling of toy balloons. Beloved of children and adult party-goers alike, the fragile toys are safer from cigarettes and fire when filled with the non-explosive, fireproof gas that has proved so useful in airships.

In 1912, just before the world war, only fifteen cubic feet of helium were known to exist. This supply was owned by the cold-temperature pioneer, Professor Onnes, of Leiden, and he valued it at $30,000. Helium was as costly, at that time, as diamonds, black pearls, and pigeon-blood rubies, and rare as radium. Only few scientists had heard of it.

But during the war a curious incident is said to have occurred that set nations thinking. A Royal Flying Corps pilot, flying a pursuit plane, encountered a Zeppelin in the clouds one day in 1917, the story goes. He opened fire with incendiary bullets and watched to see the ship burst into flame—for he knew what happens when hydrogen and incendiary bullets get together. But the Zep didn't burn, and it kept right on going. Amazed, the pilot returned to his base and reported the mystery. The Germans had a dirigible that incendiary bullets could hit but not fire. Headquarters consulted Sir Richard Threlfall, eminent scientist. Sir Richard replied that undoubtedly the dirigible was inflated with helium gas.

There were no more fireproof Zeppelins during the war, for this single "mystery ship" probably exhausted the last cubic foot of the stuff in Germany. But it started world-wide hints for more of this strange and valuable gas.

AT THE entry of the United States into the war, the War and Navy Departments called upon the Bureau of Mines to get some helium, at any price. Already the Bureau's geologists had detected traces of helium in the natural gas of certain Texas wells. They set up the first helium-extraction plant at Fort Worth, and before the war ended 750 cylinders of helium gas were on the wharves at New Orleans ready to be shipped to France for Army observation balloons.

But it was not until 1920 that the first helium-filled airship in the United States, the CR-7, took the air. Meanwhile another plant had been erected at Dexter, Kansas, where helium was found in a curious way. For years the residents of Dexter had been smarting under the banter of their neighbors. In 1903, two drillers digging for oil, had struck a heavy flow of gas at less than 500-foot depth. Local boosters talked of an industrial boom and a celebration was prepared. But when the time came to light the gas, after appropriate oratory, it wouldn't burn. Visitors from surrounding towns snickered and went home. Their newspapers kidded Dexter wickedly.

Later a way was found to light the gas, and use it for fuel, but it was worthless as an illuminant. By chance Prof. H. C. Cady, of the University of Kansas, tested the gas and found that it (*Continued on page 131*)

Be the Tom Brown of Your Town

Everyone has heard of Tom Brown, leader of the famous Tom Brown's Clown Band, one of the highest priced musical acts, that has appeared all over the world.

If you have not seen them, you have probably heard them play on Victor Records.

First-Class Saxophonists make big money and the work is easy and pleasant. You might easily become a wizard like Tom Brown, or a great record- maker like Clyde Doerr or Bennie Krueger or Joseph Smith. $100 to $500 weekly is not unusual for such musicians to earn.

BUESCHER
True Tone Saxophone

The many patented improvements, found only on the Buescher, assure a more beautiful tone, finer and more accurate tune and easier blowing qualities.

Easy to Play—Easy to Pay

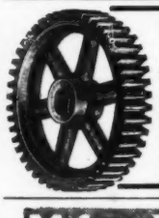
Because of its many advantages, the Buescher Saxophone is remarkably easy to master. The rapid progress you make will surprise you. Easy payments can be arranged, if desired.

6 Days' Trial

in your own home on any Buescher Saxophone, Cornet, Trumpet, Trombone or other instrument. Fill out and mail coupon for full information. Mention instrument in which you are interested.

Buescher Band Instrument Co.
2683 Buescher Block Elkhart, Indiana

BUESCHER BAND INSTRUMENT CO. (490)
2683 Buescher Block, Elkhart, Ind.
Gentlemen: Without obligating me in any way please send me your free literature.
I am interested in the following instrument.....
Name.....
Address.....



GEARS
All Kinds-Small

The most accurate made and prices reasonable. We carry a complete line of gears in stock for immediate shipment. Can also quote on special gears of all kinds. Send us your inquiries.

Write for Catalogue 214
CHICAGO STOCK GEAR WORKS
105 South Jefferson Street Chicago

Makes Ford a Tractor

We furnish everything for converting Ford Auto Chassis into Farm Tractor for truck growers, small farms, nurseries, etc. Pulls 16-in. Plow, Disce, Seeds, Cultivates; Runs Belt Machinery. We also build Garden Tractors and Cutter Bar Mower Attachments. Write for Free Particulars.

SHAW MFG. CO.
Dept. P.S.2
Galesburg, Kansas

Handles Easily. Turns in 16-ft. Circle.

IMPROVES Your Radio

The HAMMARLUND "Midline" Condenser

Condensers come and condensers go, but the Hammarlund "Midline" *keeps ahead.*

Built with watch-like precision and embodying every feature demanded of a modern tuning instrument, the Hammarlund "Midline" Condenser continues to make radio history.

If you know radio, you know Hammarlund. If you are a beginner, ask any radio engineer his estimate of Hammarlund Products. Follow his advice.

Write Dept. PS2 for Folder

Hammarlund Manufacturing Co.

424-438 W. 33rd St., New York

For Better Radio
Hammarlund PRECISION PRODUCTS

Dust off the Cobwebs

BRING out the phonograph and get new thrills from the combining of your victrola and radio by means of a Carter Radio-Phono attachment: All the favorites just when you want them. No rewiring necessary—a revelation you'll enjoy. *Illustrated folder on request. Write*

Carter Radio Co.,
300 S. Racine Ave.,
Chicago, Illinois

Carter

"The Majority's Choice."

A definite program for getting ahead financially will be found on page four of this issue.

Liquefied Helium Boils on Ice and "Freezes" Tin

(Continued from page 130)

contained nearly two per cent of helium. A 15,000 cubic-foot-a-day plant went up, drills found still richer helium at greater depths, and at the end of 1917 the plant was running. A plant was also opened in Canada, where helium had also been discovered in smaller quantities, but was shut down when the war ended.

When news came that the Petrolia gas field of Texas, which included the Fort Worth plant and two others, was nearing exhaustion, a hasty search for new fields was made. The result of this is the new plant at Amarillo, Texas, which embodies in its machinery the latest methods of helium extraction developed by the Bureau of Mines.

To extract helium from natural gas, the gas is piped from the well into mighty compressors where it is squeezed and then chilled to a temperature of 300 degrees below zero. At this searing cold, everything but the helium turns to liquid. The helium is then drawn off, still a gas, and squeezed again into cylinders or tank cars for transportation to the air field, while the natural gas, actually improved in quality by the helium extraction, is sold for light and fuel as a by-product. Formerly the chilling process had to be performed in several stages, at great expense, but the Bureau of Mines has so perfected the system that the whole process is now a single operation.

One of the few remaining difficulties was the transportation of the gas. Formerly it was shipped only in cylinders, of which it took 13,000 to fill the ill-fated *Shenandoah* at her first inflation. With the co-operation of a great steel concern, a special tank car was devised that consists of three steel tanks forty feet long and nearly five feet in diameter, mounted on a flat base. They contain helium forced in under the crushing pressure of 2,000 pounds to the square inch. Twelve of these carloads will fill the *Los Angeles*.

A final problem was the purification of helium from an airship's gasbag, contaminated by air filtering through the envelope after a long flight. Three purifying plants have been built by the Bureau of Mines, one of them a mobile plant in a railroad car. A stationary plant, at Scott Field, Ill., can reclaim 10,000 cubic feet of pure helium in an hour.

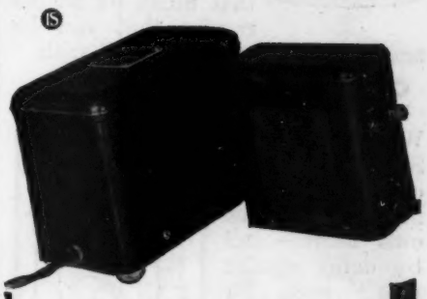
Huge Machine Makes Trick Shots for the Movies

IN THE latest moving picture technique, the camera is used much in the same manner as the human eye, seemingly wandering up and down and to the left and right at will. This new technique is responsible for the life-like quality of such scenes as, for example, a performance of a trapeze artist in the top of a circus tent, followed by a closeup of a section of the staring, breathless audience below.

How are such sequences made? F. W. Murnau, the German motion picture director, now in this country, in collaboration with experts of a steel company, has perfected the device that makes the "trick-shots" possible. It is a twenty-ton piece of machinery, resembling a derrick, with an upright mast in the form of a telescopic piston which can be shortened or lengthened. A horizontal boom also can be increased or decreased at will. To this boom either a platform or cage is fastened, and it is upon the platform or in the cage that the camera men work. The cage is used when downward "shots" are made. If the platform is employed, the photographers and their equipment are strapped in place, to prevent them being hurled into space by the swift motion of the boom in describing its arcs.

The telescopic mast of the device is operated by hydraulic power, while the boom is worked electrically.

THE NEW TAPERING CHARGERS



TAPERING the charging rate automatically. The new Elkon Chargers have added another feature to their many advantages:—

Dry—no acids, no water, no corrosion, no bulbs, no tubes, no noise, no moving parts, high charging rate when the battery is low, low charging rate when the battery is high.

The Tapering Charger, 1 Ampere, maximum charging rate is the ideal power supply for the storage battery. Leave it on all the time, without interfering with reception and without injuring the battery. Long life. Instructions and Guarantee printed on container.

The 3 Ampere Tapering Charger is ideal for the rapid charging of either radio or automobile batteries. Has all the advantages of a smaller charger.

No attention needed—just plug them in and forget them. Elkon Rectifiers are self-healing! They are not affected by accidental overloading or line surges!

ELKON Replacement Rectifiers

This exclusive feature of the Elkon Rectifiers is saving customers millions of dollars! After a long time—5000 hours for battery chargers—a year or so for "A" Eliminators, renewing the rectifier will prove to be an economy. The old rectifier may be slipped out and the new one put in—only a minute required—and the unit is as good as new.

If you have a power unit using a dry rectifier, ask your dealer about the Elkon Replacement Units. Remember Elkon is the only unit authorized by Fansteel to replace the acid jars in the Balkite power units.

ELKON, INC.
Division of
P. R. Mallory & Co., Inc.
350 Madison Ave. New York City

ELKON, INC.,
Dept. E-12, 350 Madison Ave., New York City

Send me complete information on the Elkon Radio Products.

Name_____

Address_____

This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

Make big money from repair work

Practically every householder spends at least $10.00 to $50.00 each year and many spend several times that much on simple repairs that can be made *quickly, easily* and *well* with

SMOOTH-ON No. 1

With a can of Smooth-On you can save this money in your own home — and by doing similar repair work for others, you can make money.

Leak at radiator joint stopped with Smooth-On

No skill is required to make repairs and the amount of Smooth-On used on any one job seldom costs more than a few cents.

Typical repairs that can be made perfectly with Smooth-On:—Stopping leaks in steam, water, gas, oil or stove pipes, mending cracks, breaks or leaks in furnaces and boilers, radiators, tanks, sinks, pots and pails, making loose handles tight on umbrellas, knives, hammers, brushes, drawers, etc., tightening loose screws, hooks, locks, door knobs, etc.

On the Automobile:—Making cracked water jackets and pumps good as new, stopping leaks in radiator, hose connections, gas tank and gas, oil and exhaust lines, making a fume-proof joint between exhaust pipe and tonneau heater, tightening loose headlight posts, keeping grease cups, hub caps, and nuts from loosening and falling off, etc.

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To get perfect results, write to us for and *use* the Smooth-On Repair Book. Free if you return the coupon.

Get Smooth-On No. 1 in 7-oz., 1-lb. or 5-lb. tins at any hardware store or if necessary direct from us.

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Name.....

Address.....

.....

2-29

Men and Ideas Setting the Pace in Aviation

(*Continued from page 41*)

craft could escape the novel gun's peppering.

Its mechanism moves the gun barrel to weave a regular pattern of fire, automatically, in a way that gives it the covering power of a shotgun instead of a rifle. An adjustment adapts it for long or short range. Tests of the device are planned by the Army Air Corps at Wright Field, Dayton, O.

Fights Fire in the Air

WHAT is said to be the only automatic fire extinguisher for planes has recently been introduced by an American plane-building firm. The device, a European invention, consists of a central chemical tank from which seven pipes terminate in nozzles at strategic points particularly subject to fire. Should a blaze start, the nozzles immediately could loose a high pressure spray to extinguish it.

"Prop" Blades Made Hollow

SOLID propeller blades may go out of style if six new experimental models recently ordered by the Navy prove successful. The new blades, of chrome vanadium steel, are hollow. They are said to be the first of this type that can withstand the strains of a high-speed airplane. Besides being light in weight, the odd air screws are economical to build. A recently-invented arc welding process joins two halves to make the finished propeller.

Hops from Train—Crash!

A CHICAGO pilot tried to take off, in his plane, from the roof of a speeding railroad train the other day. His plane was wrecked but the flyer escaped unhurt.

Eddie Ballough, the commercial pilot who made the try, was seeking to show the possibility of dispatching air mail from a moving train. His diminutive Monocoupe machine was secured to the top of an Illinois Central train outbound from Chicago. When the train was making sixty miles an hour a cross current lifted one wing and the plane went out of control and crashed upon the northbound tracks. Ballough crawled out of the smashed cockpit with only a scratched knee to show for the mishap.

"Aerial Fish Express"

AN INTERNATIONAL "aerial fish express" is soon to be established between Mexico and the United States, according to a Mexican government official. Refrigerator airplanes are to rush cargoes of perishable sea food between Laguna Madre, Mexico, and Houston, Texas. The novel project is backed by Houston business men, who have purchased planes for the service.

Duration Record Stands

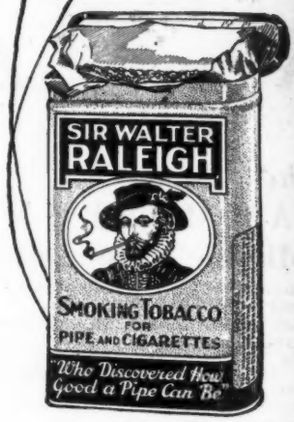
RECOGNITION by the U. S. branch of the "F. A. I.," world aero governing body, makes official the new American duration record of fifty-nine hours in the air, set not long ago by the round-the-world aviators William Brock and Edward Schlee. The world's record is held by Germans.

Even Ice Cream by Air Mail

TWO quarts of ice cream recently traveled from Utica, N. Y., to Texas via air mail, to be eaten there next day. With the container, the bundle weighed twelve pounds and bore $18.50 in air mail stamps.

Hundred-mile-an-hour mail delivery has sped other odd items on their way; everything from bread to pawn tickets and jewelry.

Milder than what?



WELL, milder than what you've been smoking. Milder, and mellower, and for two perfectly good reasons: it's choice leaf and it's aged more carefully in the warehouse. Result, Sir Walter's favorite smoking mixture has so much genuine distinction of flavor and fragrance that sophisticated pipe smokers are prompt to recognize it and grow enthusiastic.

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(for the United States only)

If your favorite tobacconist does not carry Sir Walter Raleigh, send us his name and address. In return for this courtesy, we'll be delighted to send *you* without charge a full-size tin of this *milder* pipe mixture.

Dept. 183 Brown and Williamson Tobacco Corporation
Winston-Salem, North Carolina

B&W PRODUCT

SIR WALTER RALEIGH

Who discovered how good a pipe can be

It's *milder*

Prospecting for Gold with Electricity

(*Continued from page 26*)

a radio direction-finder to trace the underground currents' path by their magnetic effect in the air.

The leapfrog method consisted of laying wires on the ground side by side, taking electric measurements, and then lifting or "leapfrogging" one wire over the others and repeating the readings.

In another experiment the prospectors found that they could use the current of three ordinary radio "B" batteries, hitched together, in place of the telegraph transmitter. Dial-reading electric instruments, instead of headphones, then measured the currents' path.

Magnetism, radio, and seismic shocks are some of the other fascinating new treasure-finding aids lumped together under the title of "geophysical prospecting."

A few ores, notably the magnetite, are magnetic. Like the lodestone of ancient mariners, which was simply a piece of magnetized iron ore, they deflect a compass needle near by, and play tricks with a more distant, but more sensitive, electromagnetic detector, such as a modern "magnetometer."

WHILE the Bureau of Mines experts were using electric instruments to survey the Caribou Mountain magnetite deposit, two experts of the Colorado School of Mines, Dr. C. A. Heiland and J. A. Malkovsky, surveyed it with a magnetometer, by taking advantage of its magnetic properties. A highly accurate map resulted that checked closely with the electric survey and the original Geologic Survey map.

Amazing mineral "finds" of gold and other precious substances have been reported by the use of radio waves. Radio waves, directed into the earth and striking an ore body, are said to cause the buried metal to rebroadcast a new radio wave, through which its location may be detected—much as a local radio station rebroadcasts, on a different wave, a program received faintly from a distant station. Sulphide ores such as those of iron, copper, zinc, and silver are described as peculiarly susceptible to discovery by radio apparatus.

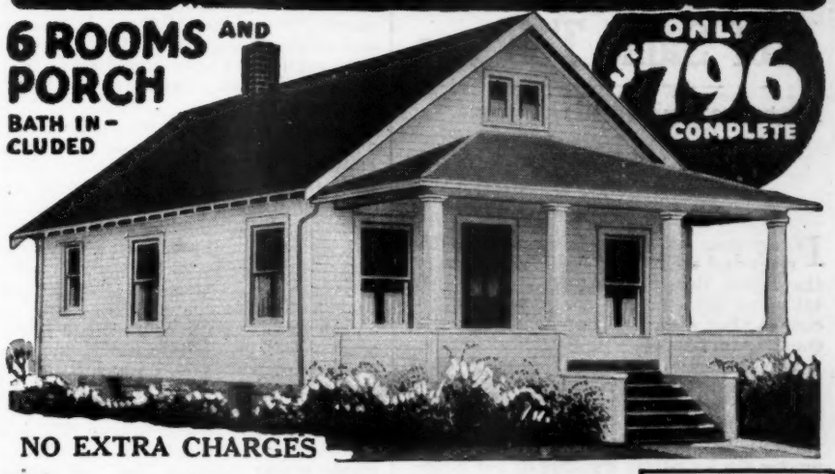
Experiments by the Bureau of Mines in a Caribou Mine Shaft to find whether radio waves would penetrate rock to any great distance showed that with a super-heterodyne radio receiver signals from above the earth could be detected at least 500 feet underground.

So successful has prospecting for oil with artificial earthquakes proved that several great oil companies are using it extensively, particularly in the San Joaquin valley in California. By measuring the speed with which earthquake waves from dynamite blasts travel through the earth, observers can tell whether underground domes of salt, which are often associated with oil pools, occur in the vicinity. The depth of a layer of possible oil-producing shale is also indicated.

Seismographs or earthquake detectors are used. These record the tremors on photographic film. In one recent method, which substitutes blasting gelatin for dynamite, a row of charges is shot off and the time of the shock's arrival indicates the depth of the underlying shale. Usually radio flashes time the earthquake wave's speed.

But this is not all. Actually weighing a portion of the earth's crust, to detect oil or ore veins beneath, is possible with an extremely sensitive weighing device known as the Eotvos balance. Because oil is lighter, and metal heavier, than the earth, the difference registers on the delicate instrument. Of course it cannot weigh directly, but resembles instead the device recently used by Dr. Paul Heyl, of the U. S. Bureau of Standards, to weigh the entire earth. Used for prospecting, it indicates the density of a portion of the earth crust.

WE PAY FREIGHT



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CONN BAND INSTRUMENTS

Justice of Peace Smokes 8395 Tins of Same Tobacco

Remains true to his favorite brand for twenty-three years

IF any man be a sound judge of what's right and what's wrong, it's Justice of the Peace Bostock. And no exceptions taken on pipe-tobaccos or any other decisions that may be handed down in the county court-house.

For twenty-three years this gentleman has rendered opinions favoring just one brand of tobacco—Edgeworth. He says he's smoked more than eight thousand tins of it! Which certainly places him high among the long-time smokers in the Edgeworth Club.

Ipswich, S. D.
Sept. 4th, 1928

Larus & Bro. Co.,
Richmond, Va.
Gentlemen:

In answer to the challenge of J. J. Roberts of Columbia, S. D., as printed in the Minneapolis Journal dated Sunday, September 2, I have smoked Edgeworth for twenty-three (23) years, and for two years previous to that time I smoked Qboid, which, I believe, is manufactured by your firm.

During this time I have smoked at least one can each day, and to verify this statement you may address the C & C Cafe of this city, where I make my tobacco purchases.

It may be interesting to know that my purchases of Edgeworth during this period have totalled more than 8395 (eight thousand three hundred ninety-five) cans, representing a total expenditure of more than $1259 (twelve hundred fifty-nine dollars).

I have never smoked any other brand of tobacco but Edgeworth during the twenty-three years.

Yours very truly,
(signed) Chas. Bostock
Justice of the Peace

Any man who stays with one brand of pipe tobacco for twenty-three years must have a pretty good reason—and in the case of Edgeworth it doubtless is because Edgeworth *never* varies.

Personal: To those who have never tried Edgeworth, we make this offer: Let us send you free samples of Edgeworth so that you may put it to the pipe-test. Simply write your name and address to Larus & Brother Company, 10 S. 21st Street, Richmond, Va. If you like these trial helpings you'll find tins of Edgeworth of the same likable quality on sale at all tobacco stores. Edgeworth Ready-Rubbed comes ready for your pipe. Edgeworth Plug Slice is for pipe-smokers who like to "rub-up" a pipeful in the palm. Both packed in pocket-size packages, in pound humidor tins and also in several handy in-between sizes.

On your radio—tune in on WRVA, Richmond, Va.—the Edgeworth Station. Wave Length 270 meters. Frequency 1110 Kilocycles.—Special Feature: The "Edgeworth Club" Hour every Wednesday evening at nine o'clock, Eastern Standard Time.

Marvels of Plane Design

(*Continued from page 54*)

body; it has almost all been absorbed into enormously thick wings. All these ideas may help, and perhaps it is just as well that airplane designs continue to be as diversified as they are today until all the promising designs have been tried.

Another way to improve the load-carrying ability of planes is to increase their power by cutting out air resistance. Landing gears, for instance, are very necessary for taking off and landing but are a nuisance in the air. Some idea of the terrific toll they take in power may be imagined from the fact that simply covering two spoked wheels, 26 by 4, with cloth cuts their twenty-eight-pound air resistance in half. And the fourteen pounds saved would enable a plane to carry 120 pounds more fuel with the same power expenditure. But suppose the whole gear, wheels, struts and all, could be tucked away in the machine's body as a bird folds its legs in flight! It sounds simple, and undoubtedly will be done in time. But mighty few designers have succeeded in producing an amply strong structure that will unfold infallibly when it should. Rather than chance wrecking a machine, they have turned instead to bringing their craft out of the early "bird cage era" by eliminating stray wires.

MORE efficient wing sections—a wing section is what one would see if the wing were sawed through in the direction of flight—help cut down power consumption. Lately Dr. Max Munk, of the National Advisory Committee's staff, has worked out astonishingly successful wing sections which, his associates believe, go a long way toward solution of the problem.

But though the finished airplane may be the last word in efficiency as to power and lift, it is useless unless its controls are infallible. Through some one's blunder, one of the new British fighting machines developed during the war could not make a right turn except by skidding—like skidding in a motor car. A British war pilot has recorded how a squadron of these machines met a German squadron and executed a skidded right turn. The Germans thought they were being "kidded," whereupon the whole Maltese-crossed squadron promptly looped the loop. After the disastrous fight that ensued, pilots of the surviving British craft speedily put their skidding machines out of commission in numerous "accidents" that may not have happened solely by chance. Fortunately new airplane designs appeared on the front about every eleven weeks.

EVEN in standard aircraft models, pilots occasionally report "dead spots" in the controls, which, in certain positions of the plane, have no effect at all. Recent studies have shown ways to combat the defect, but probably the pilot will always have to be mentally alert. When a machine stands on one wing tip, for instance, rudder and elevator take over each other's duties. Reactions to such changes must be practically instinctive.

Most persons imagine that a low speed—meaning about thirty miles an hour—is desirable for landing. True, a pilot grounding his plane at sixty miles an hour, the landing speed of some fast machines, has only one second in which to recognize obstructions eighty-eight feet ahead. But it is obvious, even to a novice, that a machine traveling fast when it lands is likely to be a shorter time within a particular zone of turbulent air than a slow-moving craft.

At low speeds control of a plane is very small, for all practical purposes. But at high speed a plane control "grips" the air, a fact that can be verified simply by swinging about a piece of cardboard in the hand.

Comfort in the air is another good reason for fast landing and flying (*Continued on page 135*)

Fits a Man's Vest-Pocket or a Woman's Purse

only 39¢ Complete

A dainty, exquisite and useful flashlight that is durable and practical. Lasts an amazingly long time. Lights as top snaps open. 5 rich color combinations: silver, and—red, blue, green, brown, black. Sold in these stores: drug, radio, hardware, electrical, automotive, and many others. Go to the nearest dealer and buy one . . . now.

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Pain is Nature's warning—don't ignore it. Such troubles as Arthritis, Rheumatism, Catarrh, Neuritis, Anemia, Lumbago, Backache, Run Down Condition and other diseases caused by impure blood—or any congestion—will be quickly relieved.

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Write for free folder on Campbell's Magnetic Health Pad and tell us your trouble. It gives full description, instructions for use, how to order, etc. Also explains 30-day free trial. Get my special introductory offer.

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The "SELF-ADJUSTING" Rheostat

This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

Marvels of Plane Design

(*Continued from page 134*)

craft. A machine that lands at low speed is slow in the air. Bumps in the air become intensified with slow cruising. A plane with a top speed of fifty miles an hour would shake its passengers black and blue on a bumpy day.

Our machines today are standardized to the extent that they have usually one body, a big wing or two in front, and a little one behind. No one knows what would happen if the rear wing were made as big as the front one. There is some experimental evidence on the subject which is not conclusive, and power-driven machines of this type have so far proved unfortunate. Another novel departure, the vertical flying "helicopter" of popular dreams, likewise awaits further development. One English inventor has spent more than $250,000 in experiments with the helicopter, while an American inventor has likewise invested great sums. Their success, though measurable, has been small.

AIRPLANE experimentation is one of the costliest things on earth, and it is this cost that keeps designers cautiously following in each other's footsteps. Formerly a new production, still in its experimental stage, would be taken from the factory and turned over to a test pilot. If the man liked the machine it would be put into production. This threw the whole decision upon the test pilot, and, being human, he was likely to make a mistake.

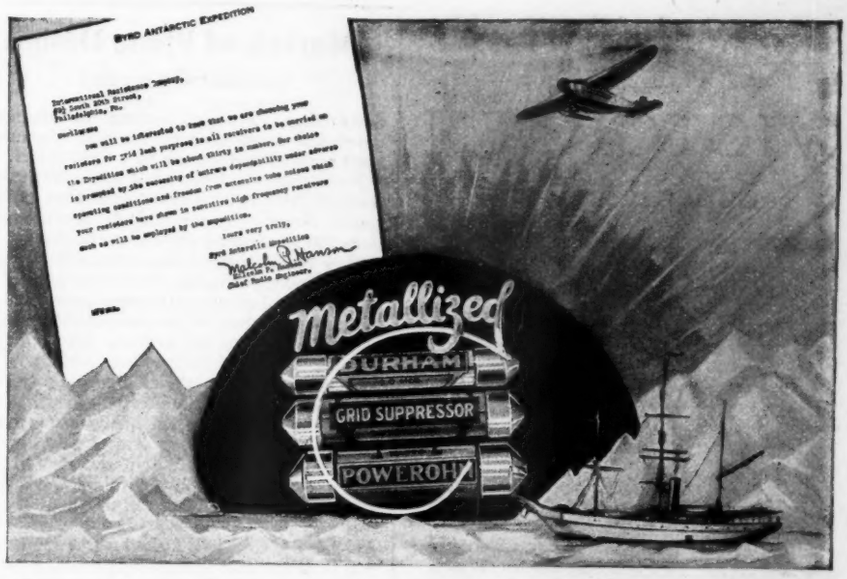
So far the most successful way of testing a new design is to construct a small model, fix it in a "wind tunnel" on suitable scales, and turn a high wind against it. Because the models are very small they must be accurately made if the result is to be reliable. This accuracy means costly hand work. If a complete wind tunnel test is run on a new design, the cost is likely to be about $1000. But by combining a wind tunnel test on a model, and tests with strain-recording instruments on the finished plane, a very complete check on the design is possible. Even so, designing a plane will remain an art, rather than a science, until the whole thing can be done mathematically.

No airplane could leave the ground, no matter how perfect its design, without a motor that is a masterpiece of engineering for its combined lightness, economy of fuel, and power. While an automobile used in city driving may burn up from a pound and a half to two pounds of gasoline each hour for every horsepower that it develops, a modern airplane engine will perform consistently on about half a pound per horsepower hour. Even a plane with a 200-horsepower motor, despite popular opinion, is economical to run; a modern machine so powered makes eight to ten miles on a gallon of gasoline.

WHO would think, after seeing the heavy cast iron of automobile engines, that a cylinder wall barely 1/16 of an inch thick is strong enough for an airplane motor that must bear far higher strains? Yet hundreds of airplane pistons dance tirelessly on their limited path, separated from the outside air only by such a narrow margin of metal.

During the war an engine that would run more than seventy hours between overhauls was considered a good one. Now there are motors that run as long as 400 hours before a general overhaul is required. No more striking excerpt from the fascinating story of the airplane engine's development could be found than the evolution of the air-cooled motor.

Only a few years ago it was thought impossible to design a really satisfactory air-cooled motor of more than 100 horsepower. Then came a period of study and testing. Heads were screwed on, bolted on, and shrunk on. Valves made of uncommon alloys were tried. One material after another was made into cylinders and tested to (*Continued on page 136*)



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Smooth, positive control of volume in all circuits. Standard types or with filament or battery switch attached, $1.50 to $3.00.

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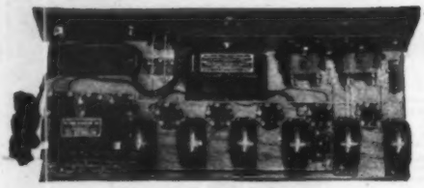


Down thru the years, from the very beginning of Radio, Victoreen has kept ahead of its time. Developments from the Victoreen Laboratories are constantly advance announcements of radical improvements in radio reception.

The New Victoreen Circuit for 1929 eclipses all past achievements. It combines unsurpassed sensitivity, selectivity and tone quality.

Perfected A. C. Operation

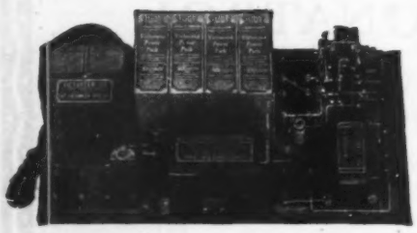
Until you have heard and used a 1929 A. C. Victoreen you cannot realize what a wonderful receiver it is. Stations that you have never heard before, together with all the old favorites, are at your instant command.

The heart of this master circuit is the Victoreen Super Transformer, vastly improved for 1929, tuned and matched to a precision of ⅛ of one per cent. In addition, the Victoreen Circuit contains improvements far ahead of its time.

Complete Kits Available Either A. C. or D. C.

Write us for complete information regarding the latest Victoreen developments.

Blue Prints and Assembly instructions are FREE. State whether you wish A. C. or D. C.



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Supplies 45, 90, 180 and 450 volts, using a UX 210 or 250 in the last stage. Contains two voltage regulator tubes so that the 90 and 180 volt taps are supplied with a constant volt potential. It is the last word in "B" supply. For the most satisfactory results you **must** have it.

Free Blue Print, with list of parts and complete assembly instructions, will be sent upon request.

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Merchandisers of Victoreen Radio Products (S)

2825 Chester Ave., Cleveland, Ohio.

Victoreen

Quality Radio Parts

Marvels of Plane Design

(Continued from page 135)

destruction. Finally Government engineers developed a cylinder with a cast aluminum head screwed and shrunk to a steel barrel.

From that point came our successful trans-ocean flights. Soon it is expected that engines cooled directly by air and developing more than 500 horsepower will be on the market.

How about water-cooled engines? Authorities estimate variously that from a third to nine-tenths of all engine failures are caused by "plumbing"—that is, gasoline and oil lines, and, in water-cooled motors, the radiator, water pump, and connections. Eliminating the troublesome water-holding parts spells a great advance in reliability, although at the expense of some increase in head resistance and vibration. The very problem of choosing between two systems, air and water cooling, is only another attraction of airplane work. The answer must come from the designer's brain.

IN COMMERCIAL freight work, one engine is more economical than any possible arrangement of two or three. Also, some operators feel strongly that one engine run a third under full load is more reliable than two smaller engines at full load. This feeling is not reciprocated by the public, and in passenger work it is very likely that three engines will have the call. Safety is of paramount importance.

There is still another possibility—no motor at all. So far it has been necessary to launch motorless airplanes, known as gliders, from a hill, or in a high wind. Some engineers stoutly maintain that man will eventually travel from place to place, in these craft, with the speed of an express train. The power will be secured from the wind. There is small likelihood, though, that anyone now more than ten years old will ever pilot one of these planes.

But there are other motors besides those that burn gasoline. How about electric motors, steam engines, or internal combustion engines of the oil-burning, Diesel type?

ONE of the lightest electric motors ever built weighed seven and a half pounds per horsepower—more than three times as much as our present gasoline motors. In fact, one of the newest aero motors is said to weigh only a pound and a half per horsepower. In extremely long flights electric motors might be valuable, dispensing with great loads of gasoline; for local work the only advantage might be reliability. And this assumes the practical realization of power transmission by wireless; for of course a plane could carry no wires.

As for steam engines, the same objection of excessive weight per horsepower applies. A typical mechanical-drive turbine that weighs 4,000 pounds may develop from thirty to five hundred horsepower, depending on steam conditions—the top figure showing only one horsepower for every eight pounds of weight. Another serious objection to steam engines for airplanes is their inefficiency. Water-jacketed boiler walls and economizers galore bring the fuel-conserving efficiency of one of the finest steam-electric plants in the country to what is considered the extraordinary figure of twenty-four and a half percent. Compared with this we find efficiencies of twenty-five percent common for gasoline airplane motors, and at least one tested at thirty-one percent.

In the field of safety there is the promising heavy-oil engine coming in the near future. With this power plant fliers can carry something approaching crude oil for fuel instead of highly inflammable gasoline, and perhaps dispense with troublesome ignition systems.

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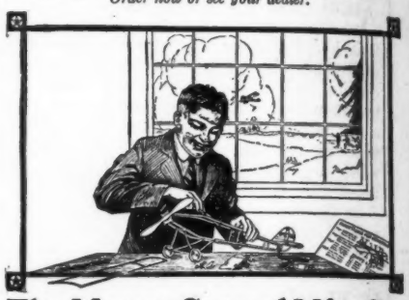

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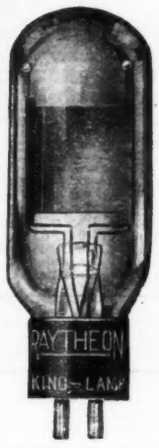

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Washington and Lincoln Both Were Inventors

(Continued from page 23)

of the boat was over the dam and was so pointed down that the water got in and sank the craft lower and lower. Things looked bad. A load of pork barrels began to slip toward the sinking end.

People from the town came out to enjoy the excitement. But to Lincoln it was no holiday. All day he worked there, trying to scheme out a method to save the boat. At last he hired another boat, brought it up as close as he could, and unloaded the pork barrels into it. Then, getting an auger, he bored a hole in the bottom of his own boat, and invited the people to come on and help weight down the other end. The water began to drain out, and the boat was saved.

"That young feller, he's got ideas," the crowd said.

Safely over the dam, Lincoln plugged up the hole and got the boat to New Orleans. But the experience made a deep impression.

TIME passed, and the former river boatman went into politics and was elected to Congress. Once, returning home from Washington by way of Niagara Falls, he was proceeding on by boat through Lake Erie. And what should happen but the very thing which had happened when he was a boatman on the way to New Orleans. The boat stuck.

The captain had faced that problem before. He piped all hands out and ordered them to take all the barrels which could be found aboard and to force them under the side of the ship below the water line. Imagine the shouting and hullabaloo that went on as this was done by the rough deck hands of the day! And then, slowly but surely, the boat began to rise. And as it rose Lincoln stood at the rail watching intently. This was his own language, something he knew about. Seventeen years ago he had wrestled with the same difficulty.

Taking a piece of paper from his pocket, Lincoln sat down, placed it on top of his high hat, and began to make some sketches.

"I think maybe I've got an idea," he said.

When he returned to Springfield he went to see a mechanic who had a shop near Lincoln's law office. The man loaned Lincoln his tools and Lincoln began to work out his invention in the man's shop. The idea of it was that, by means of a bellows, air could be forced under the ship to lift it free from its difficulty.

HE USED the tools, but much of the device he whittled out by himself. Contrast the different methods employed by Washington and Lincoln. When Washington had an idea for an invention he could have his own smith do the work for him. Lincoln had to do his own.

Lincoln began to whittle at the model, but also he had to keep his law office going, and so he took it to his office and sometimes would do some of the whittling between clients. At last, the model was finished. It was about twenty inches long. He gave it a rather long and impressive name—"An Improved Method for Lifting Vessels Over Shoals." He sent it to Washington and applied for a patent. It was granted by the issuance of Number 6,469, and Lincoln was really and actually an inventor. The model he built can be seen today in the Patent Office in Washington.

But Washington was a more practical man in this respect than Lincoln was, for Washington's inventions were used, while Lincoln's wasn't.

Like Washington, Lincoln had an interest in mechanics, but his interest was that of a lawyer. Once he delivered a lecture which he called the "Age of Different Inventions." He liked to talk and philosophize about inventions, while Washingon was interested in getting out and making an invention *work*.

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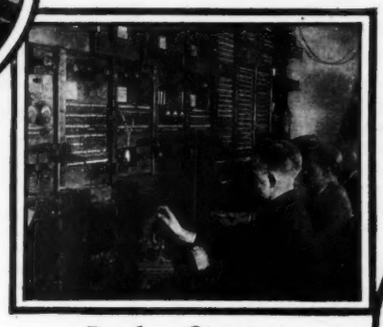

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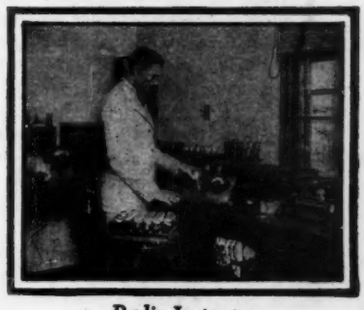

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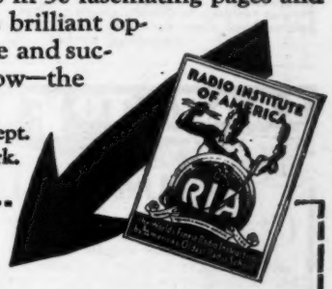

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Building the Greatest Bridge

(Continued from page 20)

that they are topped by only four or five Manhattan skyscrapers—workers balance themselves on narrow steel girders, crawl perilously along thin ledges hundreds of feet above the water, and toss red-hot rivets like jugglers.

On the New York bank of the river, along stately Riverside Drive, a mammoth steam shovel, droning and panting from behind a green board fence, picks up 15,000 cubic yards of rock at one time. Aloft, a 325-ton traveler crane grinds ponderously around, hoisting enormous masses of material that form its own rising pedestal. An endless conveyor belt, crossing the New York Central railroad tracks, carries sacks of cement and gravel from river lighters to the tower. From across the water comes the constant boom of blasting as tunnels are bored and a man-made canyon is cut through the Palisades.

PROBABLY the most intricate problem which the engineers faced was offered by the massive Palisades on the New Jersey side and the lack of such rocky heights on the New York shore. The Jersey stone gives ample anchorage for the big cables—thirty-six inches in diameter—from which the bridge will be suspended. But on the opposite bank, anchorages required a mass of concrete almost an entire city block in area and as high as a fourteen-story building! Such immense anchors are needed, for each cable must be able to resist a pull of some 65,500,000 pounds, caused by its own weight and that of the structure it will help to carry.

The cables on the Jersey bank are being buried deep in two vast wedge-shaped tunnels, bored through the rocks. These enormous caverns are to be filled with concrete. To erect the concrete anchorage on the New York side, a modern concrete plant had to be established temporarily in the midst of one of New York's exclusive residential sections. Here two huge mixers grind out 1,000 cubic yards of concrete each day!

Another engineering job of the first magnitude was the construction of the great piers on which the cable towers stand, especially on the Jersey side, where they are located in the river about fifty feet from the water's edge. Borings showed that bedrock pitched sharply away from the shore to a depth of seventy-nine feet. Not only was this rock uneven, but it was covered with a fifty-five-foot layer of mud. This problem was solved by sinking huge cofferdams—four-sided boxes open at the top and bottom and strong enough to resist terrific outside water pressure as the water within was being pumped out. In this manner, the rock floor was exposed and then solid blocks of concrete were built inside the caissons. These blocks form the bases for the two legs on which the New Jersey tower rests. And the legs need to be sturdy, for each of the cable towers contains 20,000 tons of steel—the weight of 10,000 automobiles!

HOW much will such a huge suspension bridge sag, and how will wind and weather affect it?

Here is the engineers' answer: The bridge floor will have a camber or arch of eleven feet, giving a clearance, under normal temperature and without a load, of 206 feet above mean high water at the center of the bridge and 195 feet at each tower. This provides the required elasticity, so that the structure will be able to adjust itself to expansion and contraction in its cables during summer heat and winter cold.

But under abnormal circumstances, for example, on a very hot day when the bridge is burdened with an unusually heavy load, there will be a flattening out of the camber at the center of the span. In this manner, the floor will drop about ten feet and still have an emergency safety margin.

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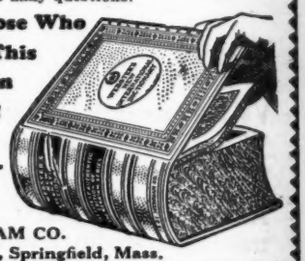

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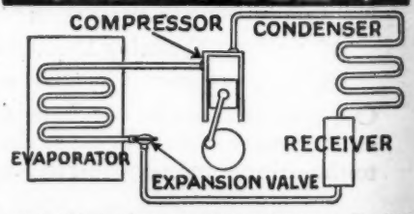

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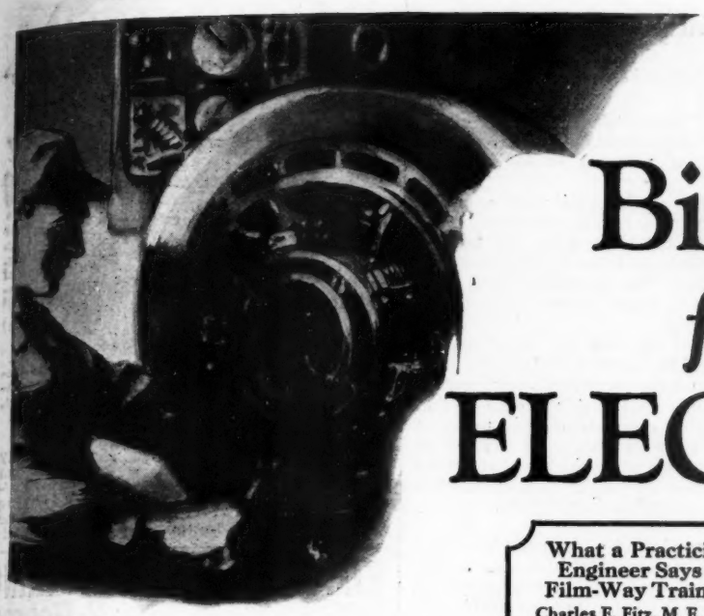

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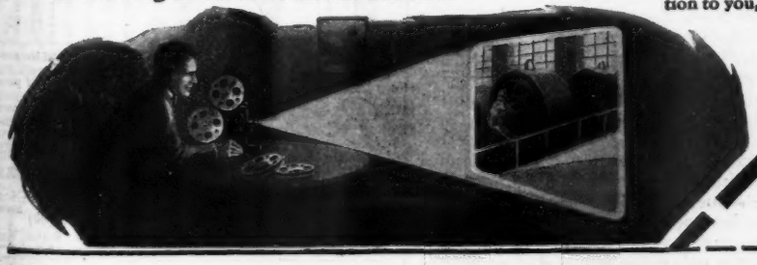

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The author, **G. E. Sterling,** is Radio Inspector and Examining Officer, Radio Division, U. S. Dept. of Commerce. The book has been edited in detail by **Robert S. Kruse** for five years Technical Editor of QST, the Magazine of the Radio Relay League. Many other experts assisted them.

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Animals Really Think

(*Continued from page 25*)

ening snarls! "Never mind," his master said then; "it's all right now." And instantly a gentle expression returned to Fellow's big brown eyes.

Fellow's first psychological test was described in POPULAR SCIENCE MONTHLY for January, 1928. Since then, he has learned many more words and also has developed a new achievement. He now responds to Herbert's injunctions when the master is hidden from view.

Scientists who watched the latest experiments expressed the opinion that few children of four or even eight years could carry out so many commands with such promptness and proficiency. They concluded that in his mind the dog has stored an amazing number of definite associations between objects and word sounds; in other words, he had done what youngsters do when learning to talk.

THE tests conducted with Black Bear and Fellow are outstanding instances of the activity in a new science, known as animal psychology, which has for its purpose not only to show that animals have intelligence, but also to determine to what extent and how they use it. Some scientists think that if a white rat, a bright dog, and a six-year-old child were to be given the same intelligence test (an experiment which as yet has not been made), it is doubtful whether the child would come out the victor.

And Dr. William T. Hornaday, who two years ago retired after twenty-eight years of service as director of the New York Zoological Park, says:

"If every man devoted to his affairs and the affairs of his city and state the same measure of intelligence and honest industry that every warm-blooded wild animal devotes to its affairs, the people of this world would abound in good health, prosperity, and happiness!"

Do animals think? Personally I believe that there is no longer any question about it! What but intelligence could account for the ingenious doings of Black Bear and Fellow, and for the all but human performances of the clever horses and dogs in the motion pictures?

Thousands have seen and admired Rin-Tin-Tin, the famous German shepherd dog that is one of the highest-priced movie stars. While his acting on the screen is fine and vivid, it is "on location" that his true innate intelligence comes to light.

NOT long ago, Rin-Tin-Tin was making a picture in which he rescued a child that had been abducted by the villain. The actor, in the character of a tramp, jumped a freight car, pursued by the dog. Aboard the train, Rin-Tin-Tin fiercely attacked the man and hurled him from the moving car. The actor was very much the worse for wear after this scene had been "shot." Then, to show that it was all in the day's work and that there were no "personal" feelings involved, Rin-Tin-Tin rushed up to the battered villain, licked his hands, and in many other ways assured him of his unbroken friendship!

Another time, the dog showed strikingly that his intelligence controls his instinct. He had received his final instructions for the acting of a thrilling scene and the director gave the command, "Camera!" when Rin-Tin-Tin saw a mouse scampering across the set. For a moment he stood undecided, struggling between two desires. Then the actor triumphed over the hunter! Dutifully he went through with the sequence; but as soon as it was finished, he bounded away and did not return until the mouse had been caught and killed.

Flash, the police-dog movie star, valued at $100,000, recently was featured in a picture that showed him as (*Continued on page 147*)

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Advice for POPULAR SCIENCE MONTHLY readers regarding safe and profitable investments. See Page 4.

Animals Really Think

(Continued from page 146)

a canine counterpart of Houdini. In the course of the story, Flash was locked in a sack and bound with ropes. When the director proceeded to show him how to loosen his bonds there were angry growls from Flash. In a minute or two, the dog freed himself with his teeth and sundry wrigglings of the body, while the camera man calmly "shot" the exciting scene. Another motion picture animal that repeatedly has given indications of intelligence is Rex, the wonder horse.

REX'S and Black Bear's uncanny powers recall the marvelous accomplishments of Clever Hans, the horse trained by Wilhelm von Osten in Germany, which, from 1906 to 1910, aroused the scientific world. Hans possessed all of Black Bear's ability, but, in addition, could recognize people from a previous glance at their photographs! The animal caused much controversy among the German professors. Numerous tests were conducted, and it was finally concluded that Hans was a "fake" and his performances a "mind-reading" stunt. All this happened before psychology—not to mention animal psychology—was taken as seriously as it is today. Somehow it never occurred to the professors that a "mind-reading stunt" presupposes the possession of a mind with which to read other minds!

They were, however, probably right in one particular—namely, that the mental accomplishments of animals trained by man, or in such constant contact with him that imitation becomes a fairly easy matter, do not offer the most convincing proof of native intelligence. To ascertain whether animals think of their own accord, one must either study them in their native haunts or in a zoological garden.

At the top of the intellectual ladder, so far as wild animals are concerned, stand, of course, the anthropoid or manlike apes. Of these, the chimpanzee is the most intelligent. The orang-utan is rated next in mental equipment. Third on the list comes the Indian elephant. In the specialized department of domestic economy, the beaver—the architect and engineer of the animal kingdom—manifests more intelligence, mechanical skill, and reasoning power than any other wild animal. And in the matter of self-preservation, zoologists reluctantly hand the palm for the greatest cunning and foresight to the common brown rat!

AS for the apes, almost every one has seen well-trained chimpanzees do their amusing imitative stunts on the stage and in the movies. But it was left for the officials of the New York Zoological Park to discover that the orang-utan possesses native inventive genius!

Some years ago Dohong, an orang-utan, developed a faculty for mechanics and invented the lever as a mechanical force as fairly, squarely, and independently as Archimedes discovered the principle of the screw!

It was a great day for Dohong when he found he could break the wooden one-and-a-half-inch horizontal bars that were held out from his cage walls on cast-iron brackets. Before his keepers could stop him, he had gleefully destroyed two and was attacking the third—with a broken piece used as a lever!

Promptly the bars were replaced by larger ones, of harder wood, but screwed to the same cast-iron brackets. For a while, Dohong was stumped. But soon the wise old ape conceived the notion of swinging his two-inch oak trapeze bar far over to one side of his cage and of applying the bar as a lever, inside the horizontal bar, from above. Naturally, the brackets gave way. They were replaced with heavy brackets of flat wrought-iron bars, one half by two and a half inches, fastened with heavy screws.

(Continued on page 148)

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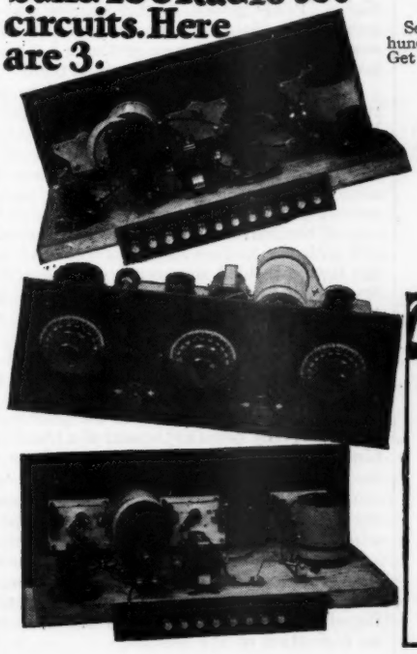

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Animals Really Think

(*Continued from page 147*)

Dohong lost no time in testing this new arrangement. But the stout brackets held securely at first. Then he got Polly, his chimpanzee companion, to assist him, Dohong pulling on the lever and Polly bracing her back against the wall and pushing on it. Nothing happened. Then, however, the orang-utan's inventive genius rose to its highest pitch. He decided to attack the brackets singly and conquer them one by one! To do this he introduced the end of his trapeze bar, chain and all, as far as it would go through the open center of the triangular bracket and gave a mighty heave, placing the end of his lever against the wall and applying his power in such a manner that few machine screws could stand the strain.

Dohong knew his hardware! One by one, the screws were pulled out of the wood, and finally each bracket he worked on was torn off, with one exception. The screws of one bracket were so firmly set in a particularly hard strip of pine that the board was at last torn out.

THIS gave Dohong another brilliant idea. He now started to pry the remaining boards off the wall. In this endeavor he was instantly checked. But it was not the last time that he used his lever discovery. For a long time, the ape had been annoyed by the fact that he couldn't get his head out between the front bars of his cage to look into the home of his next-door neighbor. Soon after his discovery of the lever and his bracket-wrecking experiments, he swung his trapeze bar to the upper corner of his cage, thrust the end of it out between the first bar and the steel column of the partition, and deftly bent two of the iron bars outward far enough to stick his head through and have his coveted peek!

New York Zoological Park attaches, too, vouch for the truth of a remarkable story demonstrating the visual associations, or perhaps the memory, of tigers. The heroes, or rather cowards, were two royal Bengals that were subdued by means of an oil painting of a fierce-looking big-game hunter!

A few years ago, the pair of great cats were imported for the zoo. On their arrival they refused to leave their shipping crates for a handsome papier maché jungle built especially for them in the lion house.

MR. AND Mrs. Tiger bit, scratched, howled, growled, and bucked, but would not budge. Prods, pokes, smoke, ammonia squirt guns, and a lasso were unavailing. As a last resort, the attendants were getting a hot-water hose, when Keeper Snyder stopped them.

Rushing into the library of the zoo, he soon returned with a large oil-painting of an African hunter. This individual, with prominent teeth, set jaw, and a general air of determination, stood with one foot on a dead lion and the other on the ground. His trusty gun was, of course, under his right arm. Approaching the rear of the barred crate, Snyder covered himself with the picture and advanced. At once the tigers subsided, apparently paralyzed with fear! Then, wildly screeching, they bolted into the make-believe jungle and hid, quaking, in a deep "thicket."

But it is not necessary to go as high in the animal kingdom as the apes and tigers to find evidences of intelligence. Who hasn't wondered at the mining ability of the prairie dog, which not only hides at the end of a blind alley fourteen feet deep and long, but, as winter sets in, also plugs up the mouth of his den with moist earth? Go lower still in the animal scale and consider the humble trapdoor spider, which digs a deep tunnel in the soil, lines it with silken wall paper, and then constructs a hinged door at the top so perfectly designed with beveled edges and so cunningly camouflaged with soil that, when it is closed, there is no indication of the burrow.

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A. C. Rewiring Simplified

(*Continued from page 66*)

running a wire from each binding post on the set that is marked for a C-voltage over to either the minus-A or plus-A binding posts.

The remaining wiring is to apply the volume control potentiometer marked *V* in Fig. 2. You can do it as shown in Fig. 2, or the same result can be accomplished by connecting the outside terminals of the potentiometer to the antenna and ground binding posts of the set and connecting the center terminal of the potentiometer to the antenna lead wire.

IF YOUR set is an old one not fitted with the power tube 171, there will be no output transformer such as is shown connected between the *P* terminal of the socket marked 171-A and the 180-volt binding post. You can fit one by following the connections shown in Fig. 2, or if there is no space inside the cabinet, the output transformer can be externally connected by hooking the loudspeaker to the output terminals of the transformer and connecting the input terminals to the plug that goes in the loudspeaker jack on the panel of the set, or to the loudspeaker binding posts, if no jack is provided.

All of the new wiring above detailed and illustrated in Fig. 2 is shown in heavy black lines.

All that remains is to connect the B-eliminator to the receiver. It has been left out of the diagram of Fig. 2 so as not to confuse you on the rewiring. Connecting the B-eliminator is very simple. The binding post marked minus-B on the eliminator is connected to the similarly marked post on the receiver. Then you connect the binding post on the eliminator marked "DET" to the 45-volt binding post of the diagram in Fig. 2 and to the center tap binding post of the 2½-volt winding on the filament heating transformer. In your receiver this binding post may also be marked "DET." Connect the 90-volt binding post on the receiver to the binding post on the eliminator marked "90," "AUDIO," or "INTER." Then connect the binding post on the eliminator marked "180" or "POWER" to the 180-volt binding post on the receiver. You will find that the filament-heating transformer has a socket into which the plug connected to the B-eliminator can be inserted. Leave disconnected the remaining binding posts on the receiver.

THE receiver can be turned on and off by inserting and pulling out the plug connected to the filament heating transformer or, if you prefer, a cord switch can be connected into the cord from the filament-heating transformer.

The volume is controlled by turning the knob of *V*. If you encounter difficulty with whistling or squealing, insert 1,000-ohm fixed resistances at one or both points marked *X* in Fig. 2.

If there are any points that do not seem quite clear to you or if you wish additional information, address your letters: Technical Editor, POPULAR SCIENCE MONTHLY, 250 Fourth Avenue, New York City.

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Another man, Wm. Shore of Neenach, California, was a cow-boy when he sent for "The Secrets of Modern Dynamic Salesmanship." Now he is a star salesman making as high as $525 in a single week. O. D. Oliver of Norman, Oklahoma, read it and jumped from $200 a month to over $10,000 a year! C. V. Champion of Danville, Illinois, raised his salary to over $10,000 a year and became President of his company in the bargain!

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Along the Road of Progress

(*Continued from page 51*)

Institute of Technology, who estimates the past history of our planet at about the same number of years.

Man, the newest of all forms of life, came into existence only about 1,000,000 years ago, a mere minute as geological and astronomical time is measured. He began to think only a few thousand years ago. So far, the one thing we know definitely is that we haven't had time yet to learn very much, by comparison with the immense number of things which remain to be found out. The discovery that every man is his own distiller is a minor revelation in the most important field of research—the study of ourselves.

Colored Snapshots—When?

ONE of the next great inventions will be a way of taking snapshots in color. Already "still" color photographs have been made, seemingly on paper, although actually consisting of transparent overlaid films. The most recent modification of this process has just been announced by F. J. Tritton, a British photographer. But beautiful as are its results, it is out of the question for the unskilled amateur to attempt. A far simpler process must be found before practical color photography can be a fact.

Meantime the latest in photography is a photographic portrait on a flat print which gives the effect of a sculptured bust. The method of making these prints, called parallax panoramograms, was invented by Dr. C. Kanolt, of the U. S. Bureau of Standards, and the camera which does the trick was devised by Dr. Herbert E. Ives, widely known television expert. The camera moves in a semicircle while the picture is being made. When the resulting photograph is looked at squarely it shows a front view of the subject, while seen from any angle it shows the face in three-quarter view or profile.

From Mountains of Mystery

PARSLEY nine feet tall and Scotch heather fifty feet high are among the vegetable curiosities growing on the slopes of the Mountains of the Moon, in Central Africa, according to Carvaeth Wells, British explorer. Every kind of fruit known in North America grows at different altitudes on the slopes of these mysterious mountains which, because of fog and cloud screens, are visible only a few hours every three or four months.

These snowcapped, equatorial mountains were known to the ancients, but for centuries modern geographers regarded them as myths.

Killed by Too Much Light

COLOR and duration of light have a decided effect upon plant growth, Dr. John M. Arthur, of the Boyce Thompson Institute, recently reported to the American Optical Society. The tomato is killed by continuous illumination; buckwheat thrives when lighted twenty-four hours a day. Ultra-violet rays, the short and invisible waves of light, while valuable in stimulating the growth of seed, have an injurious effect upon growing plants too long exposed to them, just as they have upon human beings.

The Men Prefer Blue

COLOR preferences are determined by an instrument called the "chromopathometer," invented by William E. Walton, a graduate student of psychology in the University of Kansas. Tests of 800 men and women were made with the invention. The men showed a decided preference for blue, with green second; women preferred green, with red second.

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Tides Make the Earth Boil Over

(*Continued from page 46*)

Because practically every active volcano in the world is located not far from large bodies of water, the theory is advanced by Dr. William Bowie, of the U. S. Coast and Geodetic Survey, and others, that the kneading action of the periodic tides twists the earth, forcing up the lava and causing volcanic activity.

Concerning the source of the heat that forms molten rock, or magma, one theory is that increasing internal pressure causes it. A second is that the heat is produced by chemical action. Another is that the friction of shifting layers of rock generates it. Major C. E. Dutton, a geologist of the U. S. Geological Survey, has advanced the idea that the real secret is radium! Radioactivity in the rocks, he says, is sufficient to melt them in certain places, forming large subterranean pools of lava. Added weight is given to his suggestion by the report of Dr. John Joly, British geologist, that radium is present in all igneous rocks.

ONCE lava leaves the crater of a volcano, its course down a mountainside seems governed by caprice. In the recent Mt. Etna eruption, a beautiful grove of lemon trees lay in the path of the crimson avalanche. But, just before it reached the trees, the fiery stream seemed to pause. It turned aside and attacked a heavy stone wall, which it crushed as though it were pasteboard.

At another place a gambler, taking a long chance on his luck, offered a trifling sum for a villa that seemed doomed by the approaching lava. No sooner was the bargain struck than the stream divided into two parts, cutting off a corner of the garden but avoiding the house!

Why do people persist in erecting homes on the slopes of these menacing mountains? Dr. H. S. Washington, noted volcanologist of the Carnegie Institution, explains that nowhere in the world is there such fertile vineyard ground as that produced by weathered lava. The famous grape areas of northern France and southern Germany, as well as those around Mt. Etna in Sicily, are rich in this material.

To safeguard homes near volcanos, many attempts have been made to govern the flow of lava. A sugar mill owner in Hawaii is reported to have saved his buildings by pouring water on the advancing front of a lava stream. The water "froze" and hardened the lava until a dike had been formed to turn the main stream aside down a gully. A few years ago, scientists shot chemicals into the crater of a volcano in South America in experiments to control its activity, but without success.

UNTOLD fortunes in gases and chemicals valuable to industry are wasted in the atmosphere every time a volcano lets go. "The Valley of Ten Thousand Smokes," in Alaska, a volcanic field formed by the eruption of Mount Katmai in 1912, has been called a gigantic chemical laboratory. Here thousands of fuming holes in the earth vomit steam and gases, the volume of which has been estimated at 6,000,000 gallons a second! The chemicals thus thrown away each second, according to Dr. E. G. Zies, of the Geophysical Laboratory, include sixty-four pounds of hydrochloric acid, twenty-two pounds of hydrogen sulphide, which has many important uses in industry, and nine and a half pounds of hydrofluoric acid, used for etching glass. It has been estimated that these chemicals, if they could be captured and put to use, would be worth $17,000,000 a year—more than twice the price paid by the United States for Alaska.

Many mysteries beneath the earth's crust remain to be penetrated, however, before men can hope to harness the destructive mountains. Science today is surer of what goes on millions of miles out in starry space than it is of what takes place beneath our feet.

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The Real Fathers of Flight

(*Continued from page 44*)

craftsmanship that enabled them to build the airplane. Their first experiment in wind pressure was made with a whirligig on a bicycle which they pedaled through the streets of Dayton. Their historic first flight of 1903 at Kitty Hawk, N. C., would have been a fiasco without the saving virtue of a small portion of bicycle cement!

Wilbur was twenty-five and Orville twenty-one when the brothers opened their bicycle repair shop.

"If you want your bicycle fixed right, take it to the Wright brothers," was the word shortly passed around Dayton. "They are reliable, and fair in their charges."

THE business grew into the sale of new wheels and trading in old ones. In four years the prospering owners had their own model to offer the public, the Van Cleve bicycle, named after an ancestor who helped to found Dayton. The machine was assembled by the brothers from purchased parts, yet it was first class and up-to-date. About a dozen of these wheels were sold the first year at a price around $100. The assembling shop on William Street had good equipment that included an enameling oven.

Orville had typhoid fever in 1896. He was looked after jointly by Wilbur, a trained nurse, and Katharine, home on summer vacation from Oberlin College. I can see Wilbur waving a palm leaf over the fevered patient, keeping it up with monotonous regularity, changing hands to rest muscles, perhaps speculating on a device for an automatic power fan.

"Listen, Orv," we can imagine Wilbur saying one day to his just convalescent brother, "you want to catch up on the news while you've been sick. Here is an item from Germany. Lilienthal is dead."

"Li...nthal?"

"Yes, you know—the man who tried to fly with wings. Seems to me we both read about him in some paper or magazine along with the experiments of Maxim and Langley."

"How did it happen?"

"Well, he made some short hops or glides as they call it. But the last time he fell somehow and got killed."

"Let's read up on the subject, Orv," Wilbur doubtless suggested. "I'll get what there is in the public library and you know father has a book on bird flight downstairs—*Animal Mechanism*, by a Frenchman, Professor Marey. We'll find out what there is in the whole business."

HALF an invalid through the autumn, Orville heard his brother read aloud the thin and tenuous documents dealing with flight.

Flying then was on a par with spiritism. It had no scientific basis or repute. The literature was meager though inflated with words and cloudy guesses. The brothers, hungry for definite information, tried to find something to put their teeth into. They now took turns in reading aloud on winter evenings at home. After reading, they talked, argued, dreamed, and added cloudy guesses of their own to the fog-enveloped, illusory, and haunting topic. The brothers were just playing with a fascinating idea, amusing themselves. But the idea grew upon them. Perhaps at moments each had a secret vision of adding a tiny footnote to history. The footnote would be in small type. It was several years before they saw how that type might enlarge and come to be the main text of the book of aviation.

The bicycle men of Dayton were now in the vigor of early manhood. While not robust, they were wiry and athletic. They coöperated remarkably in

(*Continued on page 153*)

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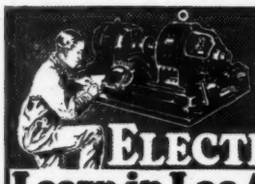

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The Real Fathers of Flight

(*Continued from page 152*)

physical as well as mental feats. For example, Wilbur was starter for Orville when the latter competed in amateur bicycle races under auspices of the local Y.M.C.A. At the pistol crack, Wilbur shoved and Orville sped five lengths ahead of all rivals. The latter still cherishes his medals of victory in these races. I saw them in his Dayton home.

They found excitement in applying their wits to the solution of mysteries like that of the bicycle pedal, which had baffled the scientific experts of manufacturers. The pedals were unscrewing, riders complained, although they were designed to tighten in use. The keenly observant Wrights detected the source of trouble and told a thankful manufacturer that friction of the pedal shank against the crank shaft negatived theory and unscrewed the pedal.

THEY sharpened their wits also on mental tests, so-called mind reading, and the tricks of spiritist mediums. They were keen scientific skeptics, putting a razor edge on their minds while training their bodies for a hazardous journey in the air. By force of circumstance they were compelled to build the flying machine of their dreams entirely in their minds. Whereas noted experimenters of the day could rely on costly test models and laboratory instruments, the two bicycle men had to think out every step and create a host of imaginary models which in turn they inspected, analyzed, criticized, tore down, rebuilt, and finally threw away. They went back to the ancient method and relied first on their brains.

They staged home battles on imaginary aircraft. It was the agreed duty of each brother to attack, punch, and smash with all vigor the other's concept. Orville proposed, Wilbur knocked; Wilbur suggested, Orville swung a destructive blow. They often fought each other to a mental standstill but did not lose their tempers, for their object was a mutual quest of truth. After a fair fight the vanquished was quick to concede victory and to adopt his opponent's viewpoint.

"I like to scrap with Orv," Wilbur used to say, "because I like to scrap with a good scrapper."

Sometimes these idea-boxers chased each other around the ring so fast that at the gong each had reversed his position and stood in the other's corner, which gave them a hearty laugh.

THEY obtained some new points to fight over in May, 1899, from pamphlets of the Smithsonian Institution, *The Aeronautical Annuals* of 1895-7, *Experiments in Aerodynamics*, by Professor Langley, published in 1891; articles by Lilienthal, and parts of Mouillard's *Empire of the Air*. They had already read Chanute's *Progress in Flying Machines*. It was all a mess of conjectures, dreams, pseudo-science, and enthusiasm. But the last item—enthusiasm!—was truly valuable to the Wrights. It kept them going when facts and reason seemed to have nothing to offer.

The Maxim and Langley group of experimenters believed in power flight, while the school of Lilienthal, Mouillard, and Chanute practiced on gliding without a motor. The men of Dayton chose the gliding approach to the problem as more sensible and economical while, too, they were fascinated by the notion of flying like birds.

"Balance is the main problem," we can imagine the brothers agree after long debate. "And it isn't practical to keep balance in the Lilienthal and Chanute style with the rider shifting his weight six ways for Sunday. Half a minute in the air seems the limit for that acrobatic stunt. (*Continued on page 154*)

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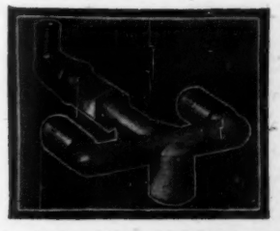

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The Real Fathers of Flight

(Continued from page 153)

Let me emphasize here that thirty seconds was the gliding record up to the Wrights and no man had flown a split second in a power machine. The record was indeed discouraging: Lilienthal the German and Pilcher the Englishman killed in gliding, then the dismal failure of power apparatus built by Maxim, Phillips, and Ader.

"Perhaps the birds can teach us," said the brothers, echoing a thought that has run down the ages from cave man to da Vinci and our own time. So on Sunday mornings the Wrights bicycled to a sandy point on the Miami River a few miles from Dayton, lay on their backs for hours, and studied the soaring flights of buzzards and hawks. At home they observed swallows and other small birds.

"WE GOT plenty of flying fever from watching the birds," Orville told me a decade and a half later, "but we learned nothing about their secret of balance."

In fact, while the airplane wing warp or equivalent flap or aileron is a bird principle, the inventors did not then know it and made an independent discovery without debt to bird or man.

In early June, 1899, the crude germ of the airplane was born in Orville's mind. It was a notion of hinged wings to be moved alternately up and down in order to secure lateral balance. At first glance this was nothing original: since time began would-be flying machines had copied bird shapes from tail to beak. Wings had been hinged to obtain propulsion or just because the birds were built that way. The distinct and original object in Orville's plan was to get sidewise balance. However, the brothers agreed the idea was mechanically impractical. They seemed to discard it, yet it remained in the bottom of their minds as a thought both rich and fertile.

Some weeks afterward, in late July, toward ten o'clock at night, Wilbur was alone in the bicycle store, which was kept open evenings to serve mechanics and factory employees who had no leisure time during the daytime to shop. A customer came into the store and the talk was like this:

"Say, Wilbur, I want an inner tube for my wheel."

"All right. Here is one."

"Good rubber, eh? Puncture-proof, too?"

"No. They all puncture. Show you another if you like."

"Wait till I look this over."

"Go ahead." He was that kind of a salesman.

IDLY twisting in his hands the pasteboard box in which the inner tube had been packed, Wilbur talked with the customer. His lean, work-scarred fingers gripped the corners of the box and twisted it in opposite directions. Wilbur glanced down, saw what his unconscious fingers were doing. His mind leaped from box to airplane wings! Here was the way to embody Orville's concept of sidewise balance through hinged wings. You can't hinge but you can twist! The effect is the same. What is the price of this tube? One dollar per wing—that is, I mean—yes, that's the right change. Thanks. A twist is a hinge. Yes, yes, thanks. Good night.

Wilbur closed the shop in a hurry and strode home to tell his brother of the magic inherent in a pasteboard box. He had to sit up waiting until midnight, for Orville had gone to some show with his sister Katharine and one of her college friends. At last the younger brother came. Under the gaslight in the living room Wilbur twisted and twisted the precious box of pasteboard, worth half a cent as a container but untold millions as man's compass toward flight. This was the *(Continued on page 155)*

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The Real Fathers of Flight

(Continued from page 154)

most important twist in history. It became the warp which in its present-day form of aileron is essential to sidewise balance of all airplanes.

"Will, I'd like to scrap with you about your twist," we can imagine Orville saying, "but it looks right. As you say, it makes my hinge practical. And I guess you're on the right track with those ideas of yours on fore-and-aft balance." (Meaning longitudinal or front-and-back equilibrium.)

It was a great night, which Orville doubtless celebrated with extra vim in his regular good-night trick of going upstairs on all fours, slapping each step with his hands. Perhaps he added the flourish of kicking up his heels, as, with hands on a chair, he used to do in boyish ecstasy when reporting some invention to his mother in the kitchen. At twenty-eight he was not quite grown up, and a lot of boy remains in him to this day.

ALTHOUGH the brothers were now working in the bicycle shop sixteen hours a day—at least it was open to customers from SIX A.M. to ten P.M.—they found time to test their discovery of the twisted box. They built their first model, the first crude ancestor of the airplane. It was a box kite or biplane with curved surfaces and open sides, five feet wide and thirteen inches deep. Its ends could be twisted or warped in the air by means of four cords attached to the corners.

Leaving Orville to tend customers at the bicycle shop, Wilbur in early August, 1899, lugged the box kite to Seminary Hill, about a mile from home, for its premier tryout. He was escorted by a gang of boys who thought it great fun that a grown-up man—he was thirty-two—should fly a kite, and a very queer one, just for their benefit. They ran alongside, shouted and called on other kids to see the show. Wilbur held in each hand a stick with two cords attached and by twisting the sticks he warped the corners of the soaring biplane and thus guided it through the air.

"Say, mister, it's no good!" shouted the boys as the flyer ducked from side to side.

They screeched in terror as the big kite made a sudden dive toward them, like a hawk on a flock of chickens, and unable to escape otherwise they threw themselves on their faces.

"It works!" thought Wilbur, grinning cheerfully at the boys.

DESPITE some oddities in the kite's conduct, the Wrights felt they were on their way, and the next step was to embody the twisting principle in a man-carrying glider. They planned the glider that winter. Aside from their own warping device, the construction or shape was that of a biplane as originated by Wenham and developed by Stringfellow and Chanute. This was one of many glider shapes between single and multiple wing types, none of which had any more inherent promise of practical flight than the tea kettle had promise of becoming a locomotive. Nor were the Wrights indebted to their predecessors for curved surfaces, all of which proved to be radically incorrect.

With lateral balance fairly assured, Wilbur suggested a horizontal rudder to obtain fore-and-aft stability as well as to elevate.

Kitty Hawk was chosen for a trial of the machine on information from the Weather Bureau at Washington that it was a place of steady winds, suitable heights, and plenty of sand to ease landing or possible drops from the air. Through spring and summer the brothers toiled at their glider in time stolen from a brisk bicycle trade. Ash ribs were steamed to a curve, struts shaped and fitted with a home-made universal (Continued on page 156)

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The Real Fathers of Flight

(*Continued from page 155*)

joint so that wires over pulleys might warp the wing structure. Wilbur shopped for the sateen wing covering. They did not assemble the glider in Dayton, and planned to get some long sticks for the frame en route.

While Orville stayed to tend shop for a time, Wilbur started for Kitty Hawk around Sept. 1, 1900, taking the materials and a camping outfit. At Norfolk, Va., the pioneer found that spruce sticks were short, eighteen instead of twenty-two feet, so that the area of the glider would have to be reduced from 200 to 165 square feet. He had worse trials and tribulations ahead. At Elizabeth City, N. C., he engaged a tub of a sailboat to voyage down marshy Pasquotank River and across Albemarle Sound. Captain Israel Perry, who was also the crew, became hysterical when they ran into a storm with loss of anchor and other gear, so that the landlubber passenger had to take charge and save the ship.

IT TOOK a week to make the 600-mile trip from home to the fishing hamlet of Kitty Hawk—a point on a strip of sand thrown up by the Atlantic for many a league along the southern coast, separated from the mainland by shallow waters of Albemarle and Pimlico Sounds. The strip is one half to three miles wide. Kitty Hawk is on the landward side at one of the wider parts, six miles from historic Roanoke Island and about sixty miles north of dreaded Cape Hatteras. While setting up camp, Wilbur stayed at the home of the local postmaster, William J. Tate. One day there was a bit of dialogue like this:

"May I use your sewing machine, Mrs. Tate?"

"Certainly, Mr. Wright, but can't I—?"

"Thank you, Mrs. Tate, I can do it myself. Just want to stitch up a pair of wings."

The postmaster's little girls shyly watched and admired the cream-hued sateen being stitched into wings by the capable stranger. I suspect they dreamed in secret envy of a better use for that beautiful cloth. Anyhow, next year the Wrights were pleased to see that the sateen, having served its first purpose, had been turned into gay dresses for the little girls.

ORVILLE joined his brother around September 25 and they hastened to finish assembly of the glider. Their wall tent, twelve by twenty feet, housed the machine, a small work bench, and themselves. They had a fair array of tools between saws, vise, and breast drill, and supplies of screws, bolts, tacks, wire and strap iron, not to mention an item that they almost regarded as a panacea for mechanical ills of every sort from slippage to fracture. I give the reader three guesses . . . yes, bicycle cement.

"Let's try it!" we can hear the impatient brothers ejaculate together when the glider was winged but yet lacked the front horizontal rudder.

They hurried it out incomplete to a sand dune, tied a rope to its nose, and with a feverish blessing let Eolus take the steed.

Hurrah! This was the reality of four years' dreams. It rose, pranced, and danced, tugged with vicious power against the arms of its enraptured creators. What a kite—no, what an air horse for a man to mount and ride on! Now they had to ride, regardless of their set program to proceed slowly. They pulled Pegasus to earth and Wilbur stretched himself on it, face downward between wings. Orville gradually loosed the rein. It gamboled upward with almost as much vigor and steadiness as before. The man on the ground exulted. It had been his boyhood passion to fly kites and now he was flying a super-kite with his brother aboard! Science?

(*Continued on page 157*)

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The Real Fathers of Flight

(*Continued from page 156*)

P'shaw, this was huge fun, the greatest sport of a lifetime.

Wilbur had another viewpoint and could not share the enthusiasm of the one below. He repented of his rashness in wanting to ride a critter so wabbly, skittish, and dangerous. He was in the air. Earth seemed far below. In quick staccato he began to yell:

"Lemme down! Lemme down! *Lemme down!*"

The wind took his voice backward and doubtless Orville let out a bit more rope, thinking his brother was cheering and wished to go higher. Then he understood the purport of the summons and hauled Wilbur down from an altitude of something like eight feet.

ORVILLE was next to ride. He went much higher and had to jump all around that bucking bronco's back to save his neck while Wilbur ran lickety split downhill. The wild ride ended with a mild smash from which Orville rose unscathed. Repairs were soon made and the front elevating rudder was attached. The brothers took turns as jockeys, a halter rope still tied to the steed. Unlike their gliding predecessors who used a sitting position, they rode in a recumbent face-downward posture, feet hooked over a rear bar as body brace, hips in a tight but movable cradle, elbows in support with hands gripping a bar that moved the elevator rudder ahead. As the hip-cradle rocked sidewise its wire connections warped the flexible wing ends, raising one side while lowering the other, an alternate screw action like twisting and untwisting a pasteboard box.

The glider was tested with varying loads without passenger and put through its paces by cord control of its novel devices. When "lift and drift" were measured, the Wrights were surprised by results very contrary to accepted figures. There was half the head resistance of framing calculated by Chanute and the lifting power was much less than the wing curve should produce according to the Lilienthal table of air pressure. They thought perhaps they needed more curve and a cloth more air-tight than sateen. Could Lilienthal and Chanute together be wrong? Well, they would build another machine next year and make the wings adjustable to various curves.

MEANWHILE they moved camp four miles south to Kill Devil Hill so as to have some real jaunts on their air nag. The sand strip here is about a mile between ocean and sound. Kill Devil Hill, so-called through Indian legend, is the largest of several sand dunes wont to change their shapes by urge of Hatteras gales. It was then about 100 feet high and had a ten-degree slope northeastward. Seagulls, fishhawks, buzzards, and eagles sailed over the sandy desert. Yet hoping poetically to learn something from the birds, the Wrights studied them in action and carefully measured the wing spread of a fishhawk which they shot.

The second day after arrival at the hill the wind fell to a favorable speed of fourteen miles an hour and they made about a dozen brief glides. Postmaster Tate went along to help launch the machine. He and one of the brothers—the other riding—would hold opposite ends of the glider and run downhill with it against the wind. As the biplane went free its pilot shimmied his hips to keep sidewise balance and with his hands shifted the forward horizontal fin to maintain a fore-and-aft even keel. It was a pleasant discovery that the pilot did not have to make a two-point landing with his feet but could make a safe stop while recumbent at twenty miles an hour. Sand flew up under the skids on landing and it was needful to shut eyes. (*Continued on page 158*)

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The Real Fathers of Flight

(*Continued from page 157*)

The glider went forward against the wind at ten or fifteen miles an hour with reference to the ground, while it traveled at twenty-five to thirty miles an hour with allowance for speed of wind. It responded quite well to its novel system of control, that is, it kept equilibrium for a number of seconds in a straightaway flight. It went up or down with the front elevating rudder.

"Although the hours and hours of practice we had hoped to obtain finally dwindled down to about two minutes," said Wilbur afterward, "we were very much pleased with the general results of the trip. . . ."

Yet the brothers doubted that it would be worth while to return to Kitty Hawk the next year and continue their scientific sport.

They had had a pleasant, exciting vacation, despite hardships of food, mosquitoes, and various other trials.

They could not see a cent of profit in their work nor any notable contribution to human knowledge. Doubtless Postmaster Tate agreed with them while he computed the junk value of the glider that had been abandoned on the crest of Kill Devil Hill. He dragged it home to use as firewood and sateen dresses for his little girls to wear.

Next month: More thrilling adventures of Wilbur and Orville Wright in their subsequent glider flights at Kitty Hawk. You'll find your interest and imagination gripped by this absorbing drama of success achieved by self-taught skill.

Now You Can Eat Sunshine

(*Continued from page 48*)

shine in bottles as well as in packages.

Strange things, these invisible rays that can give you sunburn. Under their bombardment in the dark, butter, cod liver oil, and other substances shine with a weird yellow glow, the visible evidence that their hidden vitamins are absorbing the health rays, while other oils such as peanut oil and olive oil show snow white.

Pure and impure foods may be distinguished, it has been found, by certain colors with which they shine under the wonder lamps. And one of the most important uses of all is found in the surprising ability of the rays to kill the germs that are so inimical to health.

Recently an industrial process has been developed to sterilize dried milk in huge quantities by the action of the invisible light.

Butter is nowadays made germ-free by passing it on an endless conveyor under an ultra-violet lamp.

The water used in making one of the most popular brands of pale dry ginger ale is sterilized by ultra-violet light. It is exposed to a battery of ultra-violet lights that can handle 20,000 gallons of this widely used beverage an hour.

In Great Britain sterilization of food with the rays is widely practiced. One large bakery in the north of England, for instance, exposes all its bread to the rays. For some time past hospitals have exposed all their milk to the light, which sterilizes it thoroughly and is also said to increase the content of such minerals as calcium, valuable for bone-building.

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(Continued from page 81)

walls and floor, as well as various fibers or mineral powders. One of the latter is applied with a spray gun to the walls.

That is the "skin" of the modern house. And within it lie the "nerves"—an intricate system of wires and conduits, piping electricity to every needed point, from cellar to attic, that makes the 1929 dwelling preëminently an electric home.

In living and dining rooms, abundant convenience outlets along the baseboard and in the floor avoid unsightly cords hanging from the wall whenever a bridge lamp or a toaster is to be plugged in. From the wall sockets, electric clocks give observatory time. A laboratory filled with labor-saving devices is the kitchen, where electric power runs the iron, the dishwasher sink, and even, in some of the newest homes, the kitchen range. Upstairs, the bedroom closets are equipped with switches that flash on a light automatically when you open a closet door, and shut it off when the door is closed. Convenient switches near the bed flood a room with light at a finger's touch if the baby cries or if the telephone rings. A radium-tipped screw on the switch plate glows and helps you to find it in the dark.

MODERN three- and four-way switches enable you to turn on the lights in a room from one wall switch and turn them off from another—useful in a bedroom, for instance, where you light the lamps when you enter and turn them off from the bed. Then there is a wall switch with a red warning lamp that glows to remind you when you have forgotten to extinguish the lights in attic or cellar. A new two-watt lamp, supplied with a miniature transformer that screws into a socket, glows all night with a subdued light in the nursery, sick room, or bath.

How is the 1929 home heated? So sootlessly that the entire cellar may become an extra floor for recreation and living rooms. The latest thing in heating, we found, is the "gas conversion burner," an appliance that transforms your coal-fired boiler into one that burns gas. This new burner—which, by the way, looks so much like an oil burner that you might easily mistake one for the other—conserves the heat, directing it by refractory surfaces squarely against the side of the boiler.

There are new, improved oil burner models, too, for 1929. One well-known architect told us that he never plans a dwelling today without making provision for possible installation of an oil burner. Evidently shoveling coal from a bin is going out of style, for now there is an "automatic furnace man," a device run by an electric motor, that stokes your heating plant with coal continuously without attention; it removes its own ashes and stows them in a container for easy removal.

ELECTRICITY, we learned, cannot yet compete with gas, oil, or coal for house heating as a whole. But now portable electric radiators plug into wall sockets to supply extra heat in a chilly room on very severe winter days, and in spring and fall when the furnace is not in operation. They are light enough to be carried anywhere.

This year may see a fascinating dream come true—the cooling of a whole dwelling, in midsummer, just as some of our larger theaters and restaurants are artificially cooled at present. To date, we learned, no refrigerating plant has been devised that is inexpensive enough for the private home owner to install. But one manufacturer told us that he will place such a device on the market within a few months. It will operate, for private homes, in conjunction with a heating and air-washing plant that he already is manufacturing, and will cost about as much as the rest of the plant again.

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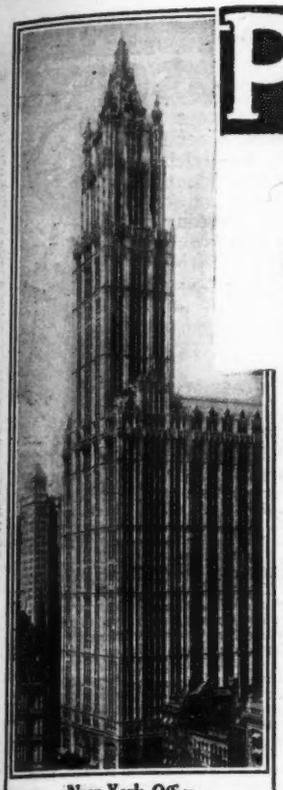

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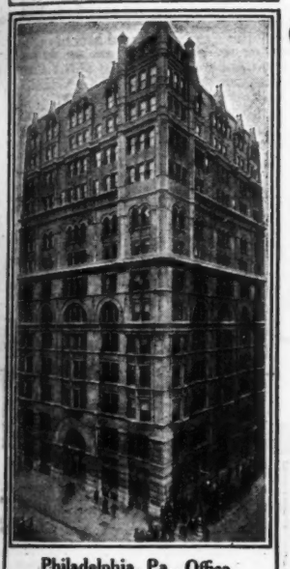

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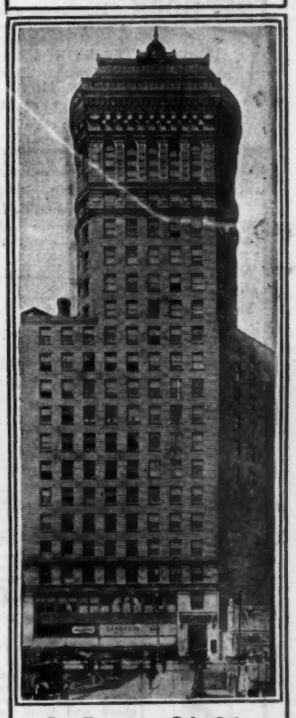

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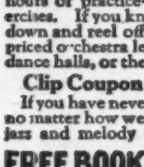

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If You Had Millions to Spend—

(*Continued from page 32*)

studied economics, chemistry, political philosophy, and international law and found time to win his blue at tennis and to captain the Pembroke College team.

A young fellow just turned twenty-three, the family concern sent him to Chile to develop the Chile Copper Company, a fresh Guggenheim mining project. When he had put the business on its feet, piped water in from forty miles away, transmitted power from the seacoast eighty miles off, set a mining town of 10,000 souls a-teeming in the desert, and started to produce more low-grade copper, at lower cost, than any other mine in the world, Harry Guggenheim felt that he could safely leave the job to other hands.

In March, 1917, enjoying a short holiday in Florida, he was one of those Americans who realized that airplanes would play an enormously important part in the war which his country was destined to enter a month later.

HE BOUGHT a Curtiss flying boat and received his first piloting instruction. Returning North, he organized a group of his friends into a unit of aviators, and eventually was commissioned Lieutenant, Junior Grade, in the Aviation Corps of the U. S. Naval Reserve.

Soon afterwards, Admiral H. I. Cone, in charge of the Naval Aviation foreign service at the time, sent Lieutenant Guggenheim across to help organize Naval air stations. Several outstanding accomplishments abroad followed, during which he was active in France, Italy, and England. At the close of the war, he returned to this country with the rank of Lieutenant Commander in the Naval Reserve Corps, the United States Naval Aviator's wings, and the Brevetto Superiore of Italy.

For a while after the war, Harry Guggenheim took part in the organization and operation of nitrate properties in Chile and tin mines in Bolivia, making an independent fortune. Then he decided to bid farewell to routine commercial business for good. He had lost his taste for it.

He felt that he could no longer lose himself in business and that it was no use to try. But he did know that he could lose himself—and be happy!—in some kind of pioneering activity of broad public significance.

But what?

THE answer came in a meeting with Chancellor Ellsworth Brown of New York University. Mr. Guggenheim was asked by the educator to assist in establishing courses in aeronautics at the institution. Here was the opportunity for which he had been looking; a service precisely in line with his experience and interests.

He composed a letter for the committee in charge of the funds-raising campaign, of which he was made a member, to be sent to a number of wealthy men, including his own uncles, appealing for aid in the establishment of the school of aeronautics. He did not know at the time that his letter was to raise more than three million dollars.

When Daniel Guggenheim, Harry's father, heard of the letter, he waxed as enthusiastic as his son, and the next day announced that he had decided himself to endow the Daniel Guggenheim School of Aeronautics at New York University. And this, don't forget, was long before the day when trans-Atlantic flying exploits had converted thousands of people, young and old, rich and poor, into aviation fans.

And in January, 1926, the elder Guggenheim decided to go a step further. He set aside a sum of two and a half million dollars for the endowment of the Daniel Guggenheim Fund for the Promotion of (*Continued on page 163*)

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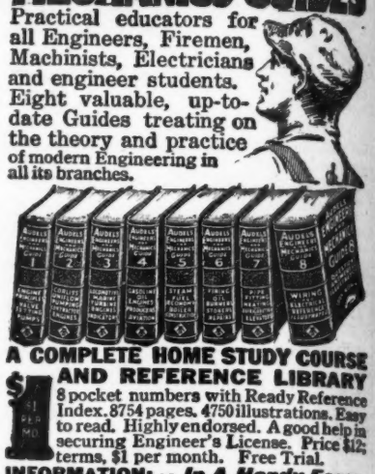

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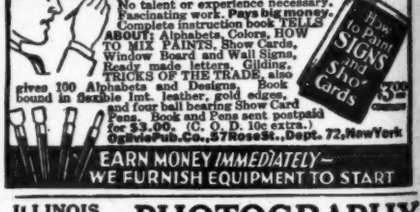

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If You Had Millions to Spend—

(*Continued from page 162*)

Aeronautics, and Harry Guggenheim became its president.

Now every working day finds Harry Guggenheim busy in his office, toiling to advance the time when a winged humanity will broaden the scope of its travels and its thinking so as to include the entire world. And that day, he firmly believes, will come within our lifetime.

"On what do you base that belief?" I asked him.

"On the extraordinary developments now taking place in aerodynamic design and in the construction and operation of aircraft," was his answer. "But to hasten the coming of universal flying, mechanical progress alone is not sufficient. The popular mind must keep pace with these advances; through constant education and demonstration of the safety and feasibility of flying as a mode of everyday transportation, the people of this country will have to acquire the attitude of faith, of confidence toward aviation.

"THE average man's attitude toward air travel today is still skeptical," he continued. "Of course, he is interested in reading of flying exploits and glad when his country's airmen set new records. But in the back of his head there lurks a deep-seated reluctance to trust that most elusive of the elements—the air. The fury of tornadoes ashore or typhoons at sea, for some reason, holds less terror for him than this paradoxical business of defying gravity with heavier-than-air machines. He may send his letters by air mail, but he prefers to let someone else do the flying!"

This, then, in brief, is the double purpose of the Guggenheim Fund: to help solve the remaining fundamental problems of aviation and to overcome popular skepticism of air transportation.

"What do you consider the fundamental flying problems that remain to be solved?" was my next question.

"There are four" he replied. "The production of an aerodynamically safe plane; the fighting of fog, one of the flyer's most merciless enemies; the development of a special aviation meteorology; and the overcoming of sleet conditions."

Then he told me of the great international Safe-Aircraft Competition which the Fund is now conducting to help find the solution of the first and perhaps most important of these problems.

"BUT mind you," he said, "that is not the only reason for the competition. It is part of our educational program as well. Through this undertaking, we hope to achieve a real advance in the safety of flying by bringing out improvements in the aerodynamic characteristics of heavier-than-air craft without sacrificing the good practical qualities of existing design. But, at the same time, we expect to demonstrate that airplane travel is basically as safe as railway and steamship transportation!"

The competition is probably the biggest single piece of work the Guggenheim Fund has attempted. As recognized an authority as Lindbergh said of it that "it ought to result in a ship comparable to the automobile for easy and safe operation."

Orville Wright is chairman of the international contest, which offers a first prize of $100,000 and five prizes of $10,000 each for the winning designs. So far, eleven entries have been made—five from this country, as many by British manufacturers, and one from Italy.

"What we aim to do," Harry Guggenheim explained, "is to encourage the development of safe aerodynamic qualities of aircraft. In accordance with the (*Continued on page 164*)

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If You Had Millions to Spend—

(*Continued from page 163*)

specifications developed for the competition, the following characteristics are sought: A plane that will land more slowly; roll only a short distance after landing; be able to make very flat glides; be able to glide steeply and in safety over obstacles surrounding the field; take off quickly and on a steep path; remain in perfect control after the stall and in all other flight attitudes; and be inherently stable, when, owing to weather conditions, the pilot cannot himself maintain an even keel.

"The plane that meets this acid test will be a pretty safe ship! It will do a great deal toward making aviation not only a young man's game, but everybody's game, like motoring. Developments now taking place strongly indicate that planes will be produced in the near future that will satisfy the requirements of our competition."

THE contest will not close until October 31, 1929, and meanwhile the Fund is marshalling its forces in its war upon fog. Although Harry Guggenheim is not now prepared to predict that the problem will be solved completely, he is very hopeful that the gravest dangers attendant upon fog-flying may soon be overcome.

The flying laboratory just established is in charge of Lieutenant James H. Doolittle, U. S. Army Air Corps, an experienced pilot of scientific and engineering training. Colonel Lindbergh, consultant of the Fund, was largely instrumental in organizing the project and acts as its special adviser.

Incidentally, when Lindbergh made his famous good-will tour of eighty-two cities which the Fund organized to dramatize the safety of flying, he landed on scheduled time, according to his custom, for every one of his stops but one, and in that case—at Portland, Me.—his lateness was due to fog.

Two biplanes, a Vought Corsair and a Consolidated NY-2, are used in the fog-fighting organization. Each plane is equipped with improved instruments designed to give the pilot his bearings in the thickest weather and to tell him his exact height above the ground at all times, thus completely robbing fog of its many perils.

The fog question naturally led to the next problem—the development of a special meteorology of aviation. Mr. Guggenheim told me that the Fund, not long ago, established a complete aeronautical weather reporting service on the Los Angeles-San Francisco airway. In this project, the organization received the coöperation of the Army, the Navy, the Department of Commerce, the Weather Bureau, and the telephone company.

IMAGINE a "main street" of the air, with the aerial equivalents of stop, go, and caution signals, which each hour and a half, from 6:30 o'clock in the morning until 3:30 o'clock in the afternoon, receives reports from thirty-three stations in an area 400 miles long and 150 miles wide, and you have an idea of the extent and significance of this service.

The stations "along the way" furnish information on winds, clouds, fog, visibility, and weather, which are flashed by wire to airports and to such planes as are equipped with radio. The service is now used by several regular airlines and a great number of individual planes. Major E. H. Bowie, in charge of the San Francisco weather bureau, is the director. Dr. C. G. Rossby, of the Massachusetts Institute of Technology, Consultant of the Fund, was prominent in organizing the work.

While on the subject of the elements, I asked Mr. Guggenheim whether he felt that transoceanic flights should be encouraged.

His answer was most emphatically in the negative!

(*Continued on page 165*)

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If You Had Millions to Spend—

(*Continued from page 164*)

"Spectacular transoceanic flights should most distinctly be discouraged!" he said. "What we should encourage is the development of equipment that will make all flying safe! Under present conditions, we are overstraining both our personnel and equipment in undertaking such feats. The splendid historic exploits of Lindbergh, Byrd, Chamberlin, Maitland and Hegenberger, Brock and Schlee, Goebel, and others were very important as a means of arousing the public imagination. But this purpose has now been served."

"And what of the future of the lighter-than-air ship?"

"At the moment the lighter-than-air craft seems to offer the only practicable means for transoceanic air travel; but our need, so far as heavier-than-air craft is concerned, is the development of seaworthy, multi-engined flying boats. America, which formerly led the world in flying boat building, is now far behind Germany and England in this regard."

"SPEAKING of transoceanic flying," I put in, "a few women—and Miss Amelia Earhart particularly—have recently distinguished themselves in the air. Do you think there is a future for women in aviation, or will flying always be exclusively a man's game?"

"Not at all! You see, aviation, contrary to the general public impression, is not confined to the pilot; though he, of course, dramatizes and, in a sense, symbolizes flying to the man (and woman) in the street. But don't forget that a large ground personnel is highly essential. I, for one, see no reason why women should not enter this field, as well as other industries.

"And then, the airplane of the future will be just as easy to operate as the automobile of today; and, therefore, in time to come, there will be in proportion as many women pilots as there are women drivers of automobiles at present."

"Then you think that all people are fit to fly?"

"By no means! On account of the great expertness required, the potentially good pilot is the exception rather than the rule. He must be physically fit, particularly alert, possess almost perfect coördination, be well-trained, and have long experience. But these requirements are bound to be eliminated in the future by the greater simplicity and safety of aircraft."

HUNDREDS of young men are deeply interested in aviation as a career, a fact attested to by numerous letters of inquiry received daily by POPULAR SCIENCE MONTHLY. For that reason, I next asked Harry Guggenheim to give his views on this subject.

He told me that, aside from its endowment of the School of Aeronautics at New York University, the Fund has made grants totaling almost $1,200,000 for laboratories, equipment, and experimental studies to the California Institute of Technology, the Massachusetts Institute of Technology, Leland Stanford University, the University of Michigan, and the University of Washington.

In addition, it has financed other educational work, including lectures on aeronautics and the publication of technical papers. And recently it organized a committee of eighty members, whose task is to solve the problem of aeronautical education in the primary and secondary schools throughout the country.

"That will give you some idea," he smiled, "of the extent to which we are interested in aviation as a career for young men! In fact this was the outstanding reason that prompted my father to endow the Fund.

"The future expansion of aviation will naturally depend largely on the character of its personnel. Young (*Continued on page 166*)

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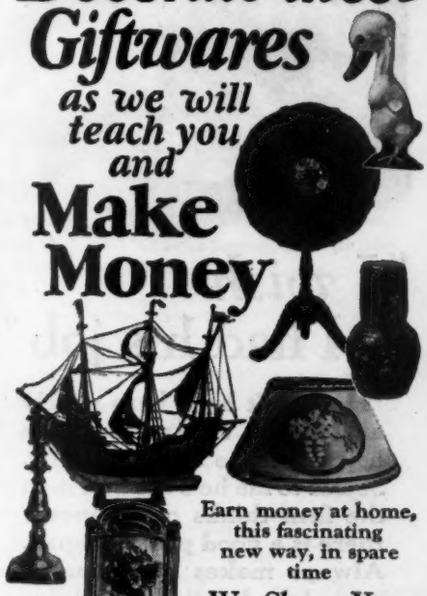

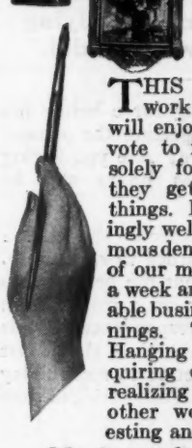

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If You Had Millions to Spend—

(Continued from page 166)

men who have had their imaginations kindled by the astonishing achievements in aviation in the past two years have been eager to take advantage of the opportunity which its rapid commercial development offers.

"We, too, receive numerous requests from young men for information concerning the training and the demand for mechanics and pilots. In order to answer these questions intelligently, the Fund not long ago addressed a questionnaire to operators of air transport companies, executives of aerial service companies, and aircraft manufacturers to ascertain to what extent a trained personnel is needed and to discover the best methods of supplying it.

"And this is what we found: The air transport companies that answered our questionnaire stated that most of their pilots were high school and college graduates with aeronautical training. When these pilots were employed, they already had an average of more than 1,000 hours of flying each to their credit. Five hundred hours of flying is the minimum required of new pilots by the air transport companies.

"Most pilots, they wrote, received their training in the regular Army or Navy or in the Reserve Corps. A few gained their experience in the commercial field. But the most desirable experience for their pilots, as the companies see it, is a combination of Army and commercial training.

"It developed that practically all aircraft manufacturers employ graduate engineers in their engineering departments. But while a technical education is deemed essential, only a small percentage of the graduate engineers employed had pursued specialized courses leading to a degree in aeronautical engineering.

"Yet, the demand for young men with highly specialized training is apparent, for the answers showed that, in employing additional personnel, the preference is given to graduates in aeronautics.

"The replies revealed that aeronautical graduates are especially needed in engineering departments where a knowledge of draftsmanship and structure is desired. For positions such as shop foremen, previous aircraft manufacturing experience is the most important requirement. On the other hand, for the higher positions a specialized education is a necessary qualification."

Here Are Correct Answers to Questions on Page 56

1. Aside from the stars and planets we can see, space is strewn with countless smaller bodies varying in size from that of an apple to the mass of a mountain. When these bodies, traveling at enormous velocity, strike the earth's atmosphere, the friction immediately raises their temperature to incandescence and we see them as shooting stars.

2. The sun, an incandescent body, radiates light of all colors, which, together, make white light. But each of the gases around it absorbs one or more of the colors, so that there are hundreds of dark bands in the spectrum. By comparing the location of these bands in the spectra of the sun and other stars with the bands produced by known substances found on earth, it has been assumed that the stars are made up of about the same materials as our own earth.

3. The distance to the nearest celestial body, the moon, is measured by simultaneously observing the angle to a given point on the moon from two widely separated points on the earth's surface and then solving the triangle thus formed by the aid

(Continued on page 167)

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Here are the Correct Answers to Questions on Page 56

(*Continued from page 166*)

of trigonometry. The distance to the sun is measured in much the same way, by sighting the planet Venus as it passes across the face of the sun. The stars similarly are measured, using the diameter of the orbit of the earth, 186,000,000 miles, as a base for the triangle.

4. Science knows more about what comets are not than about what they are. Large numbers of these mysterious celestial visitors revolve about the sun as do the planets, except that the comet's path is a tremendously elongated ellipse. Some of them are true sky wanderers. They may appear, circle around our sun, and then wander off to visit other universes. The comet is not solid. Even the brightest and most substantial looking part is thinner than the thinnest part of our atmosphere.

5. No form of life known to man could exist for a moment on the moon. It is a completely dead world. It has no atmosphere nor any water, two essentials to life as we know it. The larger planets—Neptune, Uranus, Saturn, and Jupiter—are still partly gaseous and life on them is inconceivable. There may be vegetation on Mars, and some form of animal or even human life is a bare possibility. Venus may be inhabited. If it is, the life there may resemble the life on this earth as it was countless ages ago when dinosaurs flourished. It seems logical to assume that outside of our own solar system, there must be countless planets, circling around other suns, that roughly duplicate the conditions on earth, and that life on these planets could exist.

6. The moon is far smaller than the sun, and so when the moon passes between sun and earth, its shadow is cone shaped. If the moon were smaller or farther away the apex of the cone of shadow would not touch the earth, and a total eclipse would be impossible.

7. The relatively thin ring about the planet Saturn probably consists of a swarm of meteoric stones rotating about the planet just as does the moon about the earth. The ring is approximately 3,000 miles wide and the inside edge of it is more than 80,000 miles from the planet. It is not more than 200 miles thick.

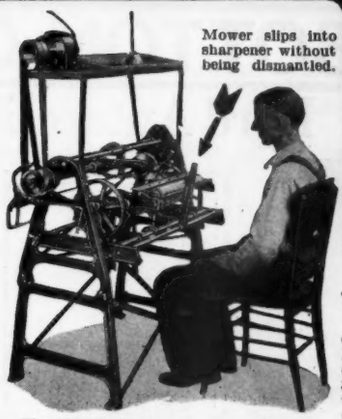
8. No one knows what is beyond the stars. The infinity of space seems to be beyond human conception. Even the fact that our most powerful telescopes reveal areas where nothing can be seen is not sure proof that there are no stars there. There may be stars so far away that their light rays cannot be detected.

9. While the stars are invisible to the unaided eye in the daytime, they can be seen through a telescope. The blue light of the sky during the day is sunlight reflected from the atmosphere. It is so bright that it obscures the stars. If there were no atmosphere, the sky would appear just as black in the daytime as it now does at night. Without atmosphere, the sun would appear as a fiery red ball floating in a sea of blackness dotted with stars.

10. While the stars appear to twinkle, the light from them is absolutely steady. The twinkling is caused by the refraction produced by air currents in our own atmosphere. If the atmosphere were still and of uniform temperature, there would be no twinkling.

Trap High-Flying Insects

INSECT traps attached to airplanes have found the pink boll weevil moths and other injurious insects, at altitudes and distances previously unsuspected, investigators of the U. S. Department of Agriculture working with Mexican officials, report.



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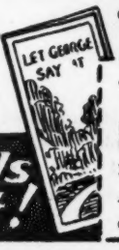

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